VOL. 1—NO. 5. MARCH 1930 (*Proceedings Vol. 26*)

JOURNAL
of the
AMERICAN CONCRETE INSTITUTE

News AMERICAN CONCRETE INSTITUTE Letter

AT NEW ORLEANS

IN GENERAL

THE CONVENTION registration at New Orleans was 306, including 28 ladies—less than half the registration at Detroit in 1929 (678), Philadelphia in 1928 (684), Chicago in 1927 (649).

An interesting thing however is the round-trip mileage of those in attendance. A hasty check with two previous annual meetings which had more than double the attendance indicates that the New Orleans convention broke all records in this respect with about 433,000 miles as against about 289,000 miles for Philadelphia in 1928 and 303,000 miles for Detroit in 1929.

The ratio of members to non-members in the New Orleans registration was high and the fact that the state in which the meeting was held and the contiguous states supplied only 25 per cent of the registration is quite different from the usual record. Conventions at Detroit, 1929 and Philadelphia, 1928, drew 70 per cent of the attendance from the state in which the meeting was held or contiguous states.

The list of registrants is published in these pages and a tabulation comparing attendance with other meetings.

So much for mere statistics. The New Orleans meeting was an experiment in other respects than in the distance the membership at large was asked to travel.

It was an experiment in the fact that there were but five technical sessions instead of seven or eight and but 21 major items on the program as compared with double that number at other meetings in recent years.

Putting the Institute's present annual output of papers and reports on the program is not only impossible with a 3-day meeting but with the monthly JOURNAL, the attempt is no longer necessary. For years the Program committee had been criticized for overcrowding the program—maintaining a schedule which stifled discussion. This year with fewer sessions and fewer items, the greater opportun-

ity did not materially increase the discussion. Whether the greater number of open periods is a benefit is something the membership must decide. New Orleans gave us good weather and a cordial welcome. A close critic—perhaps a cynical one—might question whether this agreeable combination is a contribution to the convention as a technical forum or to those attending it in their purely human attributes; and at just what point the *general* attraction of the event makes a convention successful or its product less so. Is good golf weather a boon or a bane? If so to whom or what? Thus are program committees perched precariously between the horns of a dilemma. What water-cement ratio can compete with pompano papilotte or what modulus of rupture with nimble horse flesh and a fast track? What design theories rival mossy courtyards, barred wickets and grilled porticoes of the Vieux Carre?

"A good time was had by all."

There was the comment (from a member of the Program committee) that despite some outstanding contributions the program was "thin"—lacked that scope which in variety appeals to numbers. There is already a feeling that a compromise in program extent, as between this year and former years, will be desirable. P. H. Bates, United States Bureau of Standards is, by the way, the new chairman of the Program Committee and the 1931 convention, provided satisfactory local arrangements can be made, will be in Milwaukee.

Registration began Monday morning, February 10—a day ahead of the Institute meeting—to accommodate a considerable number of early comers, including concrete products manufacturers attending the one-day sessions of the National Concrete Products Association.

	Attendance Philadelphia Conv. 1928	Attendance Detroit Conv. 1929	Attendance New Orleans Conv. 1930
Alabama	1	2	10
Arkansas	1	2	2
California	4	3	5
Colorado	0	0	2
Connecticut	9	6	3
Delaware	7	0	0
District of Columbia	19	15	4
Florida	3	1	4
Georgia	3	2	5
Illinois	35	70	46
Indiana	7	17	3
Iowa	3	2	2
Kansas	2	3	11
Kentucky	3	0	3
Louisiana	1	0	61
Maine	1	0	1
Maryland	7	0	0
Massachusetts	26	9	3
Michigan	30	293	14
Minnesota	3	3	2
Mississippi	0	3	7
Missouri	11	14	20
Nebraska	2	2	2
New Hampshire	1	0	0
New Jersey	48	16	3
New York	120	59	25
North Carolina	3	0	1
Ohio	27	49	15
Oklahoma	1	2	0
Oregon	0	1	0
Pennsylvania	261	36	22
Rhode Island	3	3	0
South Dakota	0	1	0
Tennessee	6	8	7
Texas	2	2	7
Virginia	7	1	2
West Virginia	3	2	1
Wisconsin	10	20	6
Canada	13	29	7
France	0	1	0
Norway	0	1	0
Sweden	1	0	0
	684	678	306

MAKING AND PLACING CONCRETE—1ST SESSION

When President Boyer's gavel sounded the opening of the Institute's 26th annual meeting at 2 o'clock February 11, most of those who had registered were in the room—perhaps 250.

Arthur R. Lord, first on the program, opened with a fable, indulging in sarcasm over the mythical shoulders of the Ignoravians and holding up to intelligent scorn common concreting practices which, as author-chairman of

committee 502, presenting a Proposed Construction Specification for Concrete Work on Ordinary Buildings, he sought to outlaw. Advance printing of the Proposed American Concrete Institute Specification No. 502 in the November JOURNAL had apparently drawn most of the discussion by letter, resulting in a list of amendments which Mr. Lord presented. Subject to these changes the convention voted the specifications tentative adoption. (See Proceedings pages, this JOURNAL.)

A companion document not ready for tentative adoption because not available in print for the required 30 days, is the report of Committee 503, Fabricating and Setting Reinforcing Steel, W. F. Zabriskie, author-chairman. This report, embodying, "Proposed Specifications for Supplying, Fabricating and Setting Reinforcing Steel," together with a "Steel Setters' Primer," as an appendix, was published in the JOURNAL for February. In Mr. Zabriskie's absence, R. W. Johnson, member of the committee, made an excellent outline presentation.

Discussion of this report centered around the importance of the proper location of the steel reinforcing in accordance with design, and a thorough understanding of the design by the engineer responsible for placing the steel, while it was pointed out with equal force that the designer should have sufficient field experience to enable him to make designs and notes that can be readily followed in construction. Once the steel is properly placed, care must be exercised to keep it from being disturbed during the installation of electric conduits and other fittings to be included in the concrete. The problem was summed up as requiring an evaluation of two points —design and field engineering. Convention and subsequent written discussion will appear in the JOURNAL, *Proceedings* pages in June (Vol. 26 No. 8).

MR. BURKS AND CHUTE A CARON DAM

I. E. Burks knows dramatic values and the convention was appreciative. After planning to attend the meeting, present his paper in outline (published in February JOURNAL) and standing prepared to answer the questions which a paper describing job practice usually evokes, he wrote the Secretary he couldn't be there. Past President A. E. Lindau, who as chairman of the Institute's committee 801, Durability of Concrete, had inspected the work at Kenogami, was pressed into service; studied the Burks paper on the way to New Orleans and was duly called on by the Chairman for the presentation. At the rostrum he met Burks, who, changing his mind the last minute, had slipped in late, unobserved. There was uproarious laughter and applause. Mr. Lindau sketched in a background of the interesting local situation where Chute a Caron Dam is being built under careful control conditions in spite of extraordinary difficulties. Mr. Burks followed with a brief and interesting statement of outstanding practices of his job—vibrators used in placing a stiff mix and the use of "bob-tailed" aggregate (large aggregate with a gap in the sizes as a means of avoiding raveling in stock piles and segregation in the mix) and winter conditions and practice. There is no temperature limit for placing concrete. Concrete at 85° F. is placed when air temperatures are as low as —50° F.

The reaction to the paper was evident in discussion—curing and winter protection, of special interest—and in numerous questions (some of which Mr.

Burks had answered fully in his published paper). The convention and subsequent written discussion is scheduled (as announced in the February JOURNAL) for publication in the JOURNAL for June.

SPECIFICATIONS FOR READY-MIXED CONCRETE

A progress report of Committee 504 with Proposed Specifications for Ready-Mixed Concrete was presented by Miles N. Clair, author-chairman with the statement that the reaction of all members of the committee had not been obtained. The author-chairman suggested that action of the Institute on the report of the committee be deferred for another year, and that the designation of the committee be changed from "Centrally Mixed" to "Ready-Mixed" concrete.

Mr. Clair referred with favorable comment to the central mixing plant described by Mr. Burks as placing 1000 cu. yds. a day in the Chute a Caron Dam four miles from the mixing plant.

Written discussion by R. S. Greenman, presented by Mr. Clair, cited that the specification presupposes proper equipment for furnishing ready-mixed concrete, and made the suggestion that a statement or certification as to the quality of the concrete be furnished by the plant operator when required, and not at any such frequent intervals as tentatively specified. Other suggestions included giving consideration to furnishing concrete of a required strength rather than of definite proportions. Another factor mentioned as being important is the requirement that the centrally mixed concrete be delivered in an agitated state, unless the maximum slump is 2½ inches.

A suggested basis for paying for the mixed concrete was actual volume by measurement rather than computed volume to avoid possible "shrinkage" of the concrete in the forms when compared with computed volume. These proposed specifications will be discussed in the June JOURNAL, 1930.

Presentation of the report of Committee 603 on design and operation of central mixing plants was postponed to the Wednesday evening session.

TUESDAY EVENING, FEB. 11—CURING

The first session was devoted chiefly to mixing and placing problems and the second session, at which A. R. Lord presided, was given largely to consideration of curing.

H. F. Gonnerman's paper, "Study of Methods of Curing Concrete" as published in the February JOURNAL was the subject of much interesting discussion of the relative value of materials and methods other than water for curing. While the trend of opinion was that water is the most dependable curing agent, other methods become more important when water is scarce. Calcium chloride admixture was deemed an accelerator and not a curing agent.

The author outlined his paper referring to the compression tests on 6 x 12 in. cylinders, flexure tests on 7 x 7 x 38-in. beams and wear and absorption tests on 8 x 8 x 5 in. blocks of concrete of a quality ordinarily used in road construction.

Four general groups of tests were discussed: (1) water curing, (2) surface coatings, (3) calcium chloride admixture and (4) calcium chloride surface coverings. It was attempted to eliminate variables due to differences in moisture content and all conclusions were made on tests of specimens in saturated conditions.

D. D. McGuire referred to a research project carried on in the field by Ten-

nessee State Highway Department including breaking 128,000 specimens. Comparisons are to be made of standard methods and other types of curing based upon sections across the paving slab, all conditions as near equal as possible.

The opinion was expressed by Lieut. Com. Moreell that the use of calcium chloride in hot dry temperatures leads to flaking of the concrete and also that the effectiveness of bituminous coatings depends upon the temperature and climatic conditions. In his experience such coatings resulted in increased cracking of the pavements when compared with damp earth covering, and for a hot climate wet earth or straw was found most effective for curing concrete. It was on this that Mr. Maguire countered that where water is scarce even for mixing, there is none to spare for curing.

The variation in portland cements was stated to have little or no effect upon the final results when compared with different methods of curing. Discussion of Mr. Gonnerman's paper is scheduled for publication in the June JOURNAL.

WINTER CONCRETING METHODS

The report of Committee 604, prepared by R. C. Johnson, author-chairman and published in the February JOURNAL, was outlined by R. B. Young as showing the "how" and "why" of winter concreting, paying more attention to the "how" than to the "why." Mr. Young pointed out the statement that concrete should be kept wet for 7 days and that the author states "this can be done."

The importance of preventing the green concrete from freezing was emphasized, as concrete that is allowed to freeze before it hardens is permanently damaged. Stress was put on the fact that construction loads of light buildings are often greater than the live loads for which the design provides—an added reason for careful curing procedure. The concrete must be cured until it resists the weather as well as providing the proper strength for the load. The committee's report covering buildings chiefly is to be amplified by a later report to include other construction. (June 30, JOURNAL).

In the discussion the question was raised as to the maximum allowable temperature at which concrete can be placed without danger of flash set of the cement. While 110° F. was advocated in one case as the maximum, an instance was cited by Prof. R. E. Davis in which tests showed no retrogression in strength for concrete placed at 150° F.

VARIATIONS IN CEMENTS

P. H. Bates referred to his paper on "Variations in Standard Portland Cements" (November JOURNAL) stating that its chief value is in bringing out the vast gaps in our present day knowledge of cements. If the cements vary in their qualities, the concrete made from these cements varies accordingly.

D. D. McGuire, Tennessee and L. H. Koenitzer, Kansas reported that extensive tests are being made in recognition of cement variations as a basis of concrete road programs. (See discussion *Proceedings* Pages, this JOURNAL.)

In commenting on P. M. Woodworth's paper on high pressure steam curing, A. R. Lord, presiding as chairman, cited that several years ago much was heard about high pressure steam curing and today we are coming back

to the subject for concrete masonry units. Mr. Woodworth's paper was read by W. H. Crume, in whose plant at Dayton, the tests were made.

WEDNESDAY MORNING—CONCRETE PRODUCTS—DUFF ABRAMS, CHAIRMAN

In his paper "Volume Changes in concrete Masonry Units," W. D. M. Allan called attention to the fact that in recent years there has been a rapidly increasing use of concrete masonry in larger buildings resulting in large wall areas of above-grade construction. With these extended wall areas, the occurrence of extensive shrinkage after the application of the finish coat of stucco or plaster may cause the formation of unsightly plaster cracks.

While the occurrence of plaster cracks in concrete masonry has been due mostly to faulty construction such as inadequate footings or improper bonding between different types of masonry construction, there are instances where such cracking was caused by wall shrinkage. Preliminary studies have indicated that moisture content of the units at the time the wall is erected is an important factor affecting shrinkage of the hardened concrete masonry wall.

The purpose of the investigation was to determine the rate and extent of shrinkage in concrete masonry panels as affected by moisture content of the unit at the time the wall is laid. The study includes the measurement of shrinkage of 24 masonry panels and compression and absorption tests on 72 8 x 8 x 16-in. concrete masonry units. The units, made with three different aggregates—sand-gravel, Haydite and cinders—were erected in panels and tested for strength and absorption at ages of 2, 7, 28 and 90 days.

Outstanding indications from these studies are:

(1) That the use of air-dry concrete masonry units in wall construction will reduce the shrinkage to 20 to 35 per cent of that occurring when saturated units are used.

(2) That the use of units which are only partially dry, containing 2 to 5 per cent of moisture by weight will result in the major amount of shrinkage which will occur in a concrete masonry wall.

(3) For the conditions of air curing used in these studies, 26 days of air-curing was generally sufficient to obtain blocks that would result in the minimum amount of shrinkage when laid in the wall.

Methods suggested for preventing the appearance of cracks in exterior concrete masonry walls particularly in climates where heavy driving rains are encountered, include the building of pilasters with expansion joints adjoining them to take up expansion and contraction, and also laying up an entire course of masonry with a plastic mortar. It was pointed out that the expansion of mortar joints depends upon several variables. The percentage of mortar joint in a wall varies with the size of the units, and there are various properties of limes and mortars as there are different cements.

In discussion Prof. Raymond E. Davis stressed the importance of knowing the total volume change due to expansion and contraction, stating that the aggregate used seems to be an important factor in change in volume. The paper and convention discussion will be published in the April JOURNAL.

The report of Committee 708, P. M. Woodworth, author-chairman, published in the February JOURNAL was

reviewed by W. D. M. Allan in Mr. Woodworth's absence. This preliminary report is a criticism of the old A. C. I. recommended practice and a basis for a new standard practice in the manufacture of masonry units.

That a foundation is being laid for standard tests for cast stone was reported by Louis A. Falco, chairman of Committee 704. Information on practical and mechanical aspects of testing has been collected. The purpose of the present report on recommendations as to good practice in the use of cast stone is to avoid some of the abuses. The report will be published in an early issue of the JOURNAL.

COLOR

The principal known methods of coloring concrete to meet the demands for color in architecture were summed up in three classifications by Raymond Wilson, Author-chairman of committee 703, in a report which was read in Mr. Wilson's absence by C. G. Walker: (1) the integral admixture of finely divided inert color pigments; (2) the use of colored aggregates which are exposed by surface treatment after the mixture has hardened; (3) surface treatments, which may be further subdivided into penetration treatments and paints. The choice of the basic method to be used is dependent on the requirements of color and finish, the type of service and exposure and the relative costs.

A word of warning is sounded against the use of excessive amounts of pigments in concrete because of the fact that they impair the durability of the concrete when used in amounts greater than represented by certain percentages by weight of the cement used. The importance of making the concrete watertight and durable is emphasized as the most promising means of eliminating efflorescence, a cause of color impermanence. Permeability of the concrete is an important factor where coloring is to be effected by painting. Absorptiveness and chemical composition of concrete are also important factors affecting durability of the paint film.

PLANT OPERATION

The relative economy and efficiency of multiple shift operation as compared with single shift operation in products plants was the subject of considerable discussion by members of Committee 707. Benjamin Wilk's discussion as author-chairman, favoring single shift was published in the February JOURNAL. D. R. Collins, in a written discussion cited plants that were unsuccessful in operating more than one shift due to constant wear on machines without necessary repairs, and to the large numbers of pallets required for curing.

W. D. M. Allan believes that multiple shift operations have not been in use long enough to warrant conclusions. Reference was made to the continuous operation of machinery in other industries as an indication that efficiency could be increased by multiple shift operation. The several discussions will be published in the JOURNAL for June next.

WEDNESDAY EVENING, FEB. 12—REINFORCED CONCRETE AND FLOORS

The Wednesday evening session, with Past President A. E. Lindau, chairman, opened with W. A. Slater's report as to the program of committee 105, of which Mr. Slater is chairman. As reported by Mr. Slater it calls for testing 573 columns each 5 ft. long, some with end panels and others with

dowels cast in the ends. Tests are to be carried on at the Engineering Experiment Station of the University of Illinois and at the Fritz Engineering Laboratory, Lehigh University. The program exceeds in scope and number of columns to be tested all previous column tests combined, so far as the committee has ascertained.

Owing to the difficulty that would be encountered in testing full size columns, the five-foot length was adopted, its length being 7½ times the diameter of 8 in. Points to be studied in particular include so-called "flow" of concrete under load and action of longitudinal steel in the columns. Mr. Slater's report for committee 105 is scheduled for publication in the April JOURNAL.

In the absence of R. R. Zipprodt, author-chairman of Committee 405, his contribution "Economics of Tall Building Design" was read by W. E. Hart. The work of this committee is in reference to design progress in reinforced concrete building construction with respect particularly to economic limitations on height due to design considerations—notably size of columns. The report as presented at the convention—and unfortunately in Mr. Zipprodt's absence—is incomplete and as completed is scheduled for early publication in the JOURNAL. The development of height in reinforced concrete frame structures has been remarkable in recent years.

T. D. Mylrea's contribution, "Deflections of Reinforced Concrete Members," a progress report of Committee 307 was read by title and will appear in an early issue of the JOURNAL.

FLOORS

That there is a desire on the part of many interested in concrete construction to find a better way to finish concrete floors was evidenced by the interest displayed by attendants at the late evening session in the report of Committee 802 presented by John G. Ahlers, Chairman and in the discussion by W. E. Hart, secretary of the committee. This report appears in the *Proceedings* pages of this JOURNAL.

CENTRAL CONCRETE PLANTS

The preliminary work of Committee 603 "Design and Operation of Central Mixing Plants," Frank I. Ginsberg, chairman, was reported in a symposium with brief papers by Miles N. Clair, H. F. Thomson, N. D. Crowley, A. W. Munsell and F. C. Wilcox. All are published in the *Proceedings* pages, this JOURNAL.

NEW OFFICERS

At the opening of the afternoon session on Thursday, which was the last technical session of the convention, a vote of thanks was extended to the local committee in New Orleans for the hearty cooperation given in making the convention a success and arranging for visits to local points of interest by the membership and attendants in general.

Following President Boyer's address (see *Proceedings* pages, this JOURNAL) the following officers and directors were declared elected in accordance with a canvass of ballots by the tellers:

President, Duff A. Abrams; Vice-President A. R. Lord; Treasurer, Harvey Whipple; Directors R. B. Young, Toronto, 1st District; Cloyd M. Chapman, New York City, 2nd District; Raymond E. Davis, Berkeley, Calif., 6th District.

The Board of Direction appointed F. R. McMillan director fifth district to fill the unexpired term to February

1931, of Mr. Lord, who was elected vice-president.

The terms of new officers begin, according to the By-Laws, after the close of the convention. In a graceful introduction of the new president, Past President A. E. Lindau referred to the Abrams water-cement ratio theory as of even more importance to the concrete industry than the earlier work of Abrams on the bond of concrete to steel, Bulletin 71, University of Illinois, which Professor Talbot had termed a classic.

BONNET CARRE SPILLWAY

Under the subject "Design and Construction of the Bonnet Carre Spillway," Capt. Helmer Swenholt described in detail the problems, design considerations and methods employed on the project which is to divert Mississippi flood waters through Lake Pontchartrain. The spillway when completed will comprise a long reinforced concrete structure on pile foundations, diverting flood water at a point 35 miles upstream from the City of New Orleans. The hydraulic problems which had to be taken into consideration in the location and design had a bearing of more than ordinary importance on the project. It was necessary to provide a structure that would permit the flow of a large volume of water with a low head over the spillway. The paper is scheduled for early publication in the JOURNAL.

REVETMENT

Another equally interesting project and one of particular importance in the South where the river banks are low and require protection during flood stages, was described in detail by Lieut. Morris W. Gilland in his paper on "Making and Placing Concrete Revetment Mat."

The work described, which is being carried on by Government forces with specially designed government plant and equipment, comprises paving the river banks with mats made of precast reinforced concrete slabs coupled together by non-corroding metal ties. Successive courses are placed from the top of the banks out into the center of the stream by letting the blanket of joined concrete slabs pay off the decks of the scow, like the top of a roll-top desk. The methods used are new and interesting. The paper will appear in an early JOURNAL.

SHORE PROTECTION

The problem of gulf shore protection particularly in territory where the land is not of sufficient value to permit levying heavy special assessments to support the improvements, was outlined by J. B. Converse in his interesting paper which will appear in *Proceedings* pages of the JOURNAL in April. Mr. Converse described the types of reinforced concrete structure designed and built after a complete study of storm and hurricane records in the territory involved.

OIL WELLS

Before the close of the last session of the convention C. A. Bullen, service engineer, Lehigh Portland Cement Co. outlined the problems ordinarily met in the oil field and described the methods which have proved most successful in cementing oil wells. This discussion had been prepared following a preliminary announcement that a paper by J. F. Hough on cementing oil wells would be presented at the convention. The final program omitted the subject because Mr. Hough could not be present—much to the disappointment of several, especially interested, in attendance. Cementing oil wells is

done to (1) shut out water; (2) prevent collapse of casing; (3) prevent corrosion of casing; (4) prevent gas blow-outs; (5) make shooting with TNT possible without injury to the casing.

Specially equipped trucks with high pressure pumps are used, the process in general being described as putting the cement grout into the casing and forcing down a plug which in turn forces the grout outside around the casing. After the grout has hardened the plug is drilled out leaving the inside of the casing clear.

Among the improper practices encountered and reported by Mr. Bullen were the use of excessive amounts of accelerators—sometimes equal parts of accelerator and cement—and the use of cement that had become caked in the sack due to exposure to moisture.

In the ensuing discussion the fact was brought out that test specimens subjected to sufficient pressure to force out all the water except that required for hydration of the cement showed practically the maximum strength of the concrete had developed at the age of 24 hours.

ANNUAL DINNER

At the 26th annual dinner Thursday evening after the last technical session President Edward D. Boyer presented the Leonard C. Wason Medal for the "most meritorious paper" of the 1929 convention to L. G. Lenhardt, for his "The Concrete Lining of Detroit Water Tunnels." Mr. Lenhardt who has been assistant engineer land tunnels, Department of Water Supply, Detroit, from April 1925 to date, is a graduate of the University of Michigan and with the exception of one year as Master Engineer in the U. S. Army in the United States, France and Germany, his experience has been in Detroit and vicinity.

Leonard C. Wason Research Medals, awarded to H. F. Gonnerman and P. M. Woodworth for the work reported in their 1929 paper "Tests of Retempered Concrete" were presented by President Boyer who reviewed briefly the experience of the authors of this joint paper, and noted that both attended the University of Illinois. Mr. Gonnerman remained at the University after receiving his degree and later became Research Assistant Professor in the Department of Theoretical and Applied Mechanics. In 1922 he became associate engineer in the Structural Materials Research Laboratory at Lewis Institute. Shortly after the work of the laboratory was transferred to the new laboratory of the Portland Cement Association, he became manager of the Research Laboratory, which position he now holds.

Mr. Woodworth was assistant engineer in the Research Laboratory of the Portland Cement Association from 1925 to 1929 and since 1929 has been Technical Engineer in the Cement Products Bureau of the Association.

The Henry C. Turner medal was presented to Dean F. E. Turneaure of the University of Wisconsin as an award "for distinguished service in formulating sound principles of reinforced concrete design." Dean Turneaure graduated from Cornell University and continued his studies abroad and at the University of Illinois. Later he was instructor at Washington University and then acting Dean and Professor of Engineering at the University of Wisconsin. He is co-author of "Theory and Practice of Modern Framed Structures," "Public Water Supplies," and "Principles of Reinforced Concrete Construction"

"Something different" in the way of entertainment, arranged by the local committee, was furnished by "Telesfore Boudreaux" mythical "Mayor of Bayou Pom Pom" in an address in Cajan dialect. This was followed by the pickaninny band using musical instruments made from tin cans and soap boxes. The attendance at the dinner was notable for the number of ladies present.

SIDE TRIPS

Several interesting side trips were enjoyed by convention attendants during the open periods between regular sessions. These trips, arranged for by the local committee included an afternoon on the Mississippi, attended by practically the entire convention.

Group trips were also arranged to the Bonnet Carre spillway, Ponchartrain Bridge, New Orelans water purification plant, Permanent International Trade Exhibition, H. T. Cottam Warehouse, Metairie Relief Canal and the Lone Star Cement Plant.

The ladies' program, in charge of Mrs. Ole K. Olsen, chairman of the Ladies' local entertainment committee, included the boat trip on the Mississippi river, trips on Wednesday and Thursday mornings to Newcomb college, the Orleans Club and other points of interest uptown.

On Tuesday afternoon an American Concrete Institute handicap race was run at the Louisiana Jockey Club in honor of the visiting ladies, who made presentation of flowers to the winner of the event.

Wednesday evening was informal evening at the Olsen home, the ladies being entertained by Mrs. Olsen. Interesting slides were shown of old Louisiana plantation homes and gardens.

Several trips were also arranged through the French quarter.

There were plenty of validated certificates so that a half fare return journey was possible from New Orleans and this year it was a worth while item to a large number.

CONVENTION REGISTRATION, NEW ORLEANS

FEBRUARY 11-13, 1930.

*-denotes member or representative of company membership.

*Abel, Norman, Allegheny Co., 1007 Milton Ave., Pittsburgh, Pa.
*Abrams, Duff A., International Cement Corp., 342 Madison Ave., New York City
Ace, Harvey (Architect), Louisville, Ky.
*Ahlers, John G., Barney-Ahlers Const. Corp., 110 W. 40th St., New York City
*Allan, W. D. M., Portland Cement Assoc., Chicago, Ill.
Albert, R. F., Ky. State Highway Dept., 222 Capital Ave., Frankfort, Ky.
Allaire, Alexander, The Foundation Co., 308 Red Rock Bldg., Atlanta, Ga.
Anderson, Geo. K., 5716 Cedar Ave., Philadelphia, Pa.
*Anderson, H. A., V P., The Sisalkraft Co., 205 W. Wacker Dr., Chicago, Ill.
Anderson, H. N., Natchez, Miss.
*Arnold, M. A., Pres., Arnold Stone Co., P. O. Box 3035, Jacksonville, Fla.
*Ashton, Ernest, Lehigh Cement Co., Allentown, Pa.
*Bailey, L. D., Treas., Elk River Concrete Products Co., Elk River, Minn.
*Bailey, Sam M., Jackson, Miss.
*Barr, Charles L., 902 Giddens Lane Bldg., Shreveport, La.
*Bartlett, I. L., 49 Union St., Greenfield, Mass.
*Bates, P. H., Bureau of Standards, Washington, D. C.
*Bauer, E. E., University of Illinois, 304 W. Iowa St., Urbana, Ill.
Becker, Allen G., Jahncke Service, Inc., 814 Howard Ave., New Orleans, La.
Becnel, Thos. B., 4612 Lafaye St., New Orleans, La.
Bell, G. H., Mgr., Crescent Stone Tile Co., 814 Howard Ave., New Orleans, La.
*Bigler, H. P., Rail Steel Bar Assoc., 228 No. LaSalle St., Chicago, Ill.
Boatner, Jr., Mark M., 2nd New Orleans District, New Orleans, La.

*Bogue, R. H., Portland Cement Assoc., Washington, D. C.

Boning, Jr., H. E., Ass'n of Commerce, Milwaukee, Convention Bureau, Milwaukee, Wisc.

Bowman, W. G., Engineering News-Record. New York, N. Y.

*Boyer, E. D., Universal Atlas Cement Co., New York City

*Bradley, C. M., The Youngstown Sheet & Tube Co., 237 W. 46th Ave., Gary, Ind.

*Bragger, E. Y., Medusa Portland Cement Co. Cleveland, Ohio

Brookman, Jr., Louis, Concrete Pub. Co., 400 W. Madison St., Chicago, Ill.

Brooks, Morris, Chief Bureau Building Inspection, 1911 N. 32nd St., Philadelphia, Pa.

*Brown, Frank E., Smith & Brown Engrs., 307 N. Michigan Ave., Chicago, Ill.

*Browne, H. R., Huron Portland Cement Co., Ford Bldg., Detroit, Mich.

*Bruce, W. C., 1636 Arcade Bldg., St. Louis, Mo.

*Bullen, C. A., Lehigh Portland Cement Co., 831 Conway Bldg., Chicago, Ill.

*Burks, I. E., Aluminum Co. of America, Kenogami, P. Q., Canada

*Butler, C. M., Marquette Cement Mfg. Co., LaSalle, Ill.

*Campbell, R. H., c/o Universal Atlas Cement Co., 25 Broadway, New York City.

*Capouch, M. E., American Steel & Wire Co., 208 S. LaSalle St., Chicago, Ill.

Caruthers, W. H., Birmingham Slag Co., Comer Bldg., Birmingham, Ala.

*Chapman, Cloyd M., 105 W. 40th St., New York City

Cherry, J. H., Lone Star Cement Co., New Orleans, La.

*Chittenden, Howard L., East Main St., Clinton, Conn.

*Chubb, J. H., Penn. Dixie Cement Corp., 521 5th Ave., New York City

*Clair, Miles N., V.P., The Thompson & Lichtner Co., Boston, Mass.

*Clark, W. B., Lehigh Cement Co., 1014 Bankers Bond Bldg., Birmingham, Ala.

*Clemmer, H. F., Solvay Sales Corp., 40 Rector St., New York City

*Clousing, Louis, 213 City Hall, Minneapolis, Minn.

*Coffman, Herbert, Hercules Cement Corp., 1700 Walnut St., Philadelphia, Pa.

*Collins, D. R., 87 27th St., Milwaukee Concrete Prod. Co-op. Ass'n, Milwaukee, Wisc.

*Conahey, George, Johns-Manville Corp., 292 Madison Ave., New York City

*Connar, V. N., Universal Atlas Cement Co., 516 Frick Bldg., Pittsburgh, Pa.

*Cooke, C. E., Kalman Floor Co., 22 West Monroe St., Chicago, Ill.

Converse, J. B., J. B. Converse & Co., State Office Bldg., Mobile, Ala.

Covell, Earl D., V.P., Covell Corp., 1600 Walnut St., Philadelphia, Pa.

*Cox, G. L., Pres., Cement Prod. Co., P. O. Box 935, Birmingham, Ala.

Cohen, Max, New Orleans Levee Board, New Orleans, La.

Crampton, Theo. H. M., Johns-Manville Corp., 419 Prairie Ave., Elmhurst, Ill.

*Crepps, R. B., 540 Northwestern Ave., West Lafayette, Ind.

*Crowley, N. D., Albany Trucking Corp., Albany, N. Y.

*Crume, W. H., Pres., Crume Brick Co., 511 Keiths Bldg., Dayton, Ohio

Crump, Horace E., 2 Canal St., New Orleans, La.

Dagen, A. H., Missouri State Highway Comm., Jefferson City, Mo.

*Davis, Raymond E., University of Calif., Berkeley, Calif.

*DePass, M. B., 926 Pauline St., New Orleans, La.

*Derickson, Donald, College of Engineering, Tulane University, New Orleans, La.

*Derlith, C. P., Pres., Colloy Products Co., 4030 Chouteau Ave., St. Louis, Mo.

Dix, Thomas Q., Dixoyle Incorporation, 1802 Railway Exchange Bldg., St. Louis, Mo.

*Donald, A. D., Pres., Pyramid Stone Co., Houston, Texas.

Donelson, J. E., Central Mix Plant, 1321 No. 31st St., Birmingham, Ala.

Dreisbach, Edw. E., Standard Lime & Stone Co., Martinsbury, W. Va.

*Durbin, H. R., International Cement Corp., 342 Madison Ave., New York City

Earl, Ralph, Sewerage & Water Bd. of N. O., 2125 Leonidas St., New Orleans, La.

Eastwood, R. (P. A. Engr.), Sewerage & Water Bd., N. O., 1926 Milan St., New Orleans, La.

Ebeyer, L. J., 115 David St., New Orleans, La.

*Eckert, R. T., Lehigh Portland Cement Co., 831 Conway Bldg., Chicago, Ill.

*Ellis, A. B., Pyramid Stone Co., 1503 Westheimer, Houston. Texas.

*Evans, J. Clifford, Nazareth Cement Co., Nazareth, Pa.

*Fairman, J. R., Portland Cement Assoc., 347 Madison Ave., New York City

*Falco, Louis A., The Decorative Stone Co., 198 Yale Ave., New Haven, Conn.

*Farmer, Homer G., Universal Atlas Cement Co., 208 S. LaSalle St., Chicago, Ill.

Ferguson, B. P., City Engineers Office, 1455 Webster St., New Orleans, La.
*Ferguson, Lewis R., 1401 Santa Fe Bldg., Dallas, Texas
Ferguson, Phil. M., University of Texas, 711 West 24th St.' Austin, Texas
*Ferguson, M. W., Stone Tile & Supply Co., Inc., Roanoke, Va.
Finkelstein, S., 3322 Magazine St., City Hall, New Orleans, La.
*Fleming, Paul K., Chicago Concrete Post Co., 232 E. Erie St., Chicago, Ill.
Formigli, O. L., Formigli Arch. Stone Co., 1304 Real Estate Trust Bldg., Philadelphia, Pa.
*Formigli, Paul, Formigli Arch. Stone Co., Philadelphia, Pa.
*Franklin, Jack, Franklin Equipt. Co., 7071 Plankinton Bldg., Milwaukee, Wisc.
*Frauenfelder, Herman, Algonite Stone Mfg. Co., 2024 Fair Ave., St. Louis, Mo.
Finch, Stanley P., University of Texas, Austin, Texas
Fulcher. L. H., Jackson, Miss.
*Gardiner, Lion, V. Pres., Lakewood Eng. Co., Cleveland, Ohio
Geis, John F., Johns-Manville Corp., New Orleans, La.
Gilland, Morris W., Vicksburg Engr. Distr., Greenville, Miss.
Gleason, C. R., Medusa Portland Cement Co., Memphis, Tenn.
Godat, David W., 7826 Zemple St., New Orleans, La.
*Gonnerman, H. F., Portland Cement Assoc., 33 West Grand Ave., Chicago, Ill.
*Grady, J. C., Turner Const. Co., 420 Lexington Ave., New York City.
*Haight, E. E., Pres. Concrete Publishing Co., 400 W. Madison St., Chicago, Ill.
Hale, R. S., Alabama Highway Dept., Montgomery, Ala.
*Hammerschmidt, Martin, Elmhurst Chicago Stone Co., 155 Elm Ave., Elmhurst, Ill.
*Hanna, W. C., California Portland Cement Co., Colton, Calif.
*Harter, B. D., Harter Marblecrete Stone Co., 1600 W. Main St., Oklahoma City, Okla.
*Harris, W. A., La. Highway Comm., Raleigh, N. C.
*Hart, W. E., Portland Cement Assoc., 33 W. Grand Ave., Chicago, Ill.
*Heeb, Emil, Standard Concrete Pipe & Curbing Co., 1002 Delery, New Orleans, La.
*Headley, Holland C., U. S. Bureau of Public Roads, Montgomery, Ala.
*Hedderich, H. F., Westinghouse Elec. & Mfg. Co., St. Louis, Mo.
Helfer, J. J., American Tripoli Co., 1636 Arcade Bldg., St. Louis, Mo.
Henderson, A. A., Allegheny County Dept. of Pub. Wks., 519 Smithfield St., Pittsburgh, Pa.
Henduelite, Henry B., State Highway Eng. of La., Baton Rouge, La.
Hill, Martin D., Southern Cement Prod., San Antonio, Tex.
Hogg, W. T., Bd. of Comm., Port of N. O., 7930 Belfast St., New Orleans, La.
Holland, H. D., 1512 King St., W. Toronto, Canada
*Hollister, S. C., 311 Elm Ave., Swarthmore, Pa.
*Holt, C. D., Stillwater, Okla.
*Howe, H. N., Memphis, Tenn.
*Hubbard, Fred., 133 Halleck St., Youngstown, Ohio
*Hussey, Jack W., Universal Atlas Cement Co., 4937 Chippewa St., St. Louis, Mo.
Irby, Sam, La. Highway Comm., 4202 Fontainebeau Dr., New Orleans, La.
Ittmann, Louis A., Architectural Cast Stone Co., 8122 Colapissa St., New Orleans, La.
Ines, Jr., C. A., La. Highway Comm., 940 Park Blvd., Baton Rouge, La.
*Jackson, C., Electric Tamper & Equipment Co., Chicago, Ill.
*Jahncke, Walter F., 814 Howard Ave., New Orleans, La.
James, John R., The Detroit Edison Co., 2000 2nd Ave., Detroit, Mich.
Janssen, I. J. G., La Lamore Tile Co., Arabi, La.
*Jennings, Dwight F., 2970 W. Grand Blvd., Detroit, Mich.
*Jennings, W. A., So. Portland Cement Co., Osborn, Ohio
*Johannes, Gus. H. F., Syndicate Trust Bldg., St. Louis, Mo.
*Johns, H. S., Crystalite Stone Products, Hamilton, Ont., Canada.
*Johnson, A. V., Ideal Cement Stone Co., Omaha, Nebr.
Johnson, B. M., The Flintkote Co., 1537 Conery St., New Orleans, La.
*Johnson, R. W., Engr., Concrete Reinforcing Steel Inst., Tribune Tower, Chicago, Ill.
Jones, C. L., Board of Port Comm., 2 Canal St., New Orleans, La.
Keatinge, Paul F., Universal Atlas Portland Cement Co., 411 N. 7th St., St. Louis, Mo.
Kelly, Claude, 2344 N. Rumar St., New Orleans, La.
*Kennedy, John W., Ford Bldg. Detroit, Mich.
*Kinney, Wm. M., Portland Cement Assoc., Chicago, Ill.
*Kivett, E. H., Baton Rouge, La.
*Klee, James, The American Fluresit Co., 27 E. Water St., Cincinnati, Ohio

*Klein, W. H., Chattanooga, Tenn.
*Knopel, Herbert J., Warner Co., 1513 Walnut St., Philadelphia, Pa.
*Koenitzer, L. H., Kansas State Highway Comm., Manhattan, Kansas
*Kolb, F. X., 1225 E. Gr. Blvd., Detroit, Mich.
Krebs, J. J., City Hall, New Orleans, La.
*Krehbiel, B. F., The Lusco-Brick & Stone Co., 1447 N. Meade St., Wichita, Kans.
*Krogh, A. T., W. E. & Mfg. Co., Wilkinsburg, Pa.
*Lachin, Victor, Architectural Cast Stone Co., 8122 Colapissa St., New Orleans, La.
Lahr, George R., Pres., Trenton Fords Art Stone Co., 942 Broad St., Newark, N. J.
Leach, Fred M., Detroit Savings Bank Bldg., Detroit, Mich.
*Leavitt, H. W., University of Maine, Orono, Me.
*Leftwich, F. R., Raymond Concrete Pile Co., 140 Cedar St., New York, N. Y.
*Lenhardt, L. G., 2688 Lawrence Ave., Detroit, Mich.
*Levison, Arthur A., Blaw Knox Co., Pittsburgh, Pa.
*Lindau, A. E., Union Trust Bldg., Chicago, Ill.
*Locke, Clyde E., A. E. Baxter Eng. Co., 905 Ellicott Sq., Buffalo, N. Y.
*Logan, E. H., 3504 Troost St., Kansas City, Mo.
*Lord, Arthur R., 140 S. Dearborn St., Chicago, Ill.
*Lose, Robt. G., 719 Forsyth Bldg., Atlanta, Ga.
*Lothers, John E., Oklahoma A. & M. College, Stillwater, Okla.
*Love, H. J., National Slag Assn., 937 Leader Bldg., Cleveland, Ohio
*McBeth, R. W., Kingston, Ohio
McClure, Shirely, Stillwater, Okla.
*McGuire, D. D., 418 6th Ave., N. Nashville, Tenn.
*McIntyre, Geo. E., 1009 Baltimore Ave., Kansas City, Mo.
McKiever, Wm. H., Pres., W. H. McKiever, Inc., 247 W. 13th St., New Orleans, La.
*McMillan, F. R., 33 W. Grand Ave., Chicago, Ill.
*Macatee, Walter R., Portland Cement Assn., 421 Hibernia Bank Bldg., New Orleans, La.
Madden, E. P., 1228 N. Rendon St., New Orleans, La.
Maier, William, 1829 Soniat St., New Orleans, La.
*Mandia, Jas. V., Hawkeye Portland Cement, Des Moines, Iowa.
*Markland, M. B., M. B. Markland Co., Atlantic City, N. J.
Marks, Jr., N. L., 4131 Elbo St., New Orleans, La.
*Martin, Evan S., 16 Saulter St., Toronto, Ont., Canada.
Mottram, Thos. A., Fieldmann Portland Cement Assoc., 1821 Valina St., New Orleans, La.
*Moore, O. L., Universal Atlas Cement Co., 1532-210 S. LaSalle St., Chicago, Ill.
*Morecll, Ben, Navy Dept., Washington, D. C.
Moylan, John N., American Steel & Wire Co., 208 S. LaSalle St., Chicago, Ill.
Muth, F. A., Civil Engr., U. S. Lighthouse Service, 7705 Willow St., New Orleans, La.
Nelles, John S., Detroit Edison Co., 2485 S. LaSalle Gdns., Detroit, Mich.
Noble, T. W., Thos. W. Noble & Co., Tribune Tower, Chicago, Ill.
*Norris, J. Frank, 107 Norris St., Rochester, N. Y.
*O'Brien, C. J., Calumet Steel Co., 33 No. La Salle St., Chicago, Ill.
*Olsen, Edward, Badger Concrete Co., Oshkosh, Wis.
*Olsen, Ole K., 822 Perdido St., New Orleans, La.
Onstad, Ralph M., 1513 Third St., New Orleans, La.
*Parson, D. E., U. S. Bureau of Standards, Room 157 Industrial Bldg., Washington, D. C.
Patton, D. H., Johns-Manville, 3628 St. Charles Ave., New Orleans, La.
*Pearson, J. C., Lehigh Portland Cement Co., Allentown, Pa.
*Pease, B. S., American Steel & Wire Co., 208 S. LaSalle St., Chicago, Ill.
*Perrin, Harvey, Southern Cement Prod. Co., 521 Menchaca St., San Antonio, Texas.
Pierce, George, Pierce Test. Labs., Denver, Colo.
*Porter, Jr., Harry, Alcoa Power Co., 845 Spruce St., Winnetka, Ill.
*Porter, J. L., Sewerage & Water Board, New Orleans, La.
Prevatt, W. Joe, State Highway Comm., Baton Rouge, La.
Quinlan, P. H., Asst. City Engr., City Hall, New Orleans, La.
*Rackle, E. E., Pres., The George Rackle & Sons Co., Cleveland, Ohio.
*Ratcliff, T. R., Union Station Annex, Indianapolis, Ind.
Ray, Carl J., Testing Engr., The Pierce Testing Laboratories, 734 19th St., Denver, Colo.
Rector, J. C., Dist. Mgr., The Philip Carey Co., Cincinnati, Ohio.
*Reed, Geo. L., Florida Concrete Prod. Assoc., 11 Sheridan Dr., Atlanta, Ga.

*Richart, F. E., 104 Matl. Testing Lab., University of Ill., Urbana, Ill.
*Ridge, R. S., Lawrence Portland Cement Co., 405 Harrison Bldg., Philadelphia, Pa.
Riess, John, 1309 Cadiz St., New Orleans, La.
Rittenberg, Chas. L., Board of Port Comm. of N. O. 4437 S. Rocheblane St., New Orleans, La.
*Roberts, Hugh, Lone Star Cement Co. of Ala., 2301 Comer Bldg., Birmingham, Ala.
*Robinson, H. M., Underwriters Laboratories, 207 E. Ohio St., Chicago, Ill.
*Rockwood, E. F., Deslauriers Col. Mould Co., Inc., 101 Tremont St., Boston, Mass.
*Rockwood, Nathan C., Rock Products, Chicago, Ill.
*Roos, H. W., The H. W. Roos Co., 2036 Dana Ave., Cincinnati, Ohio.
*Ross, W. B., Shell Pet. Corp., Tulsa, Okla.
Rucker, James L., Portland Cement Assoc., 2117 N. 69th St., Shreveport, La.
*Saeger, Geoff. A., Missouri Portland Cement Co., 7417 Delmar Blvd., St. Louis, Mo.
Salusbury, H. H., American Steel & Wire Co., 435 Throop St., Chicago, Ill.
*Schantz, C. P., Penna. R. R., 620 Glen Echo Road, Philadelphia, Pa.
Scharff, D. L., 1630 Pemston, New Orleans, La.
*Schevenell, V. E., V. E. Schevenell Const. Co., 1280 Walker Ave., Memphis, Tenn.
Schulz, W. F., Cons. Engr., 870 Shrine Bldg., Memphis, Tenn.
*Servey, Dan F., V.P. The Haydite Co., 203 Mutual Bldg., Kansas City, Mo.
Shifrin, H., 300 City Hall, St. Louis, Mo.
*Shilstone, Herbert M., 510 Gravier St., New Orleans, La.
Shoemaker, Charles, Warner Co., 1518 Walnut St., Philadelphia, Pa.
Skrainka, Ralph N., Skrainka Const. Co., 305 Security Bldg., St. Louis, Mo.
*Slater, Willis A., Lehigh University, Bethlehem, Pa.
*Stancliff, A. D., Lone Star Cement Co., Birmingham, Ala.
*Stanton, W. P., W. F. MacGlashan Assoc., 2910 Derby St., Berkeley, Calif.
Stevens, Rollin, Besser Mfg. Co., Alpena, Mich.
*Stewart, Frank G., Civil Engr., 5016 Camp St., New Orleans, La.
*Stineman, Norman M., Concrete Publishing Co., 400 W. Madison St., Chicago, Ill.
*Stoddard, Ralph P., 2121 Guarantee Title Bldg., Cleveland, Ohio.
*Street, Louis J., The National Testing Laboratories Ltd., 223 James St., Winnipeg, Can.
Sues, Eugene C., Jahncke Service Inc., 814 Howard Ave., New Orleans, La.
Sutch, H. E., Engr., New Orleans, La.
*Swanson, A. G., Omaha Concrete Stone Co., Omaha, Nebr.
*Sweetser, E. O., Washington University, 6025 Pershing Ave., St. Louis, Mo.
*Taege, Paul C., Arlington Concrete Products Co., Arlington Heights, Ill.
*Talbot, A. H., University of Illinois, Urbana, Ill.
*Talbot, K. H., National Equipment Corp., Milwaukee, Wisc.
*Terrell, D. V., University of Ky., Lexington, Ky.
Tarry, Eldred, Engr., 531 Savoy Court, New Orleans, La.
Thompson, J. P., Concrete Reinforcing Steel Inst., 11 W. 42nd St., New York City.
*Thompson, Scott, V.P. & Mgr., Lone Star Cement Co., 1120 Hibernia Bldg., New Orleans, La.
*Thomson, H. F., General Material Co., 605 Buder Bldg., St. Louis, Mo.
*Thomson, Wm. S., Kalman Steel Co., 410 N. Michigan Ave., Chicago, Ill.
*Tillson, H. L., American Vibrolithic Corp., Des Moines, Iowa.
Tracy, J. M., Archt., Bd. of Education, 13 S. Fitzberch St., Rochester, N. Y.
Turneaure, F. E., Dean of College of Engineering, Univ. of Wisc., Madison, Wisc.
Turner, Fred G., A. Engr., 7519 Oak St., New Orleans, La.
*Urquhart, L. C., Cornell University, Ithaca, New York.
*Vande Bogart, C., The Economy Concrete Co., New Haven, Conn.
*Van Houten, Chas., Van Houten Bros., 4536 Wentworth Ave., Chicago, Ill.
*VorKeller, Albert, Melbourne, Fla.
*Votaw, Carl, Stillwater, Okla.
*Votaw, Curtis, Holdenville, Okla.
*Walker, C. G., 33 West Grand Ave., Chicago, Ill.
*Walker, James G., Alpha Portland Cement Co., 600 American Traders Bank Bldg., Birmingham, Ala.
*Weathers, H. C., Testing Division Fla., State Road Dept.,Gainesville, Fla.
*Wetzel, E. H., Mgr., Nucarth Stone Co., Carthage, Mo.
*Whipple, Harvey, Secy., American Concrete Inst., Detroit, Mich.
White, E. H., Sisalkraft Co., 55 W. 42nd St., New York City.
White, E. L., White Stone Co., 1450 80 St., Memphis, Tenn.
*Wiedemann, Ernest A., Economy Concrete Co., Box 1223, Richmond, Va.
*Wig, R. J., 530 W. 6th St., Los Angeles, Calif.

*Wilk, Benjamin, 2977 Cortland, Detroit, Mich.
Wilkenson, M. C., Leesburg, Fla.
*Williams, M. A., Chicago Architectural Stone Co., 410 Ridge Ave., Evanston, Ill.
Williams, Malcolm E., Portland Cement Assoc., New Orleans, La.
*Willson, S. H., Kalman Floor Co., 902 Candler Bldg., Atlanta, Ga.
*Wilson, Ethel Blaine, Asst. Secy., American Concrete Inst., Detroit, Mich.
*Wilson, Lloyd, C. O. Bartlett & Snow Co., Cleveland, Ohio.
*Withrow, R. E., Medusa Portland Cement Co., Cleveland, Ohio.
*Witt, J. C., Universal Atlas Cement Co., 5834 Stony Island Ave., Chicago, Ill.
*Wright, Neldien H., Pres., Wright Cast Stone Co., Inc., Box 545 West Jackson Sta., Jackson, Miss.
Wyler, Albert G., Asst. City Engr., 3123 Toledano St., New Orleans, La.
*Young, R. B., 8 Strachan Ave., Toronto, Ont., Canada.
*Zass, W. W., State Highway Comm., Little Rock, Ark.

LADIES

Ahlers, Mrs. Estelle K., New York, N. Y.
Bailey, Mrs. Sam. M., Jackson, Miss.
Boyer, Mrs. E. D., 55 E. 10th St., New York City.
Brown, Mrs. Frank E., Chicago, Ill.
Brooks, Mrs. Morris, 1911 N. 32nd St., Philadelphia, Pa.
Capouch, Mrs. M. E., 7438 South Shore Drive, Chicago, Ill.
Derickson, Mrs. Donald, 1311 Henry Clay Ave., New Orleans, La.
Gregory, Mrs. N. B., 630 Pine St., New Orleans, La.
Haight, Mrs. E. E., 815 Bluff St., Glencoe, Ill.
Klee, Mrs. James, 1322 Avon Drive, Cincinnati, Ohio.
Knopel, Mrs. Herbert J., Philadelphia, Pa.
Kennedy, Mrs. John W., Detroit, Mich.
Locke, Mrs. Clyde E., 207 Colvin Ave., Buffalo, N. Y.
Macatee, Mrs. W. R., New Orleans, La.
Markland, Mrs. M. B., Atlantic City, N. J.
Nelles, Mrs. J. S., 2485 LaSalle Gdns., Detroit, Mich.
Olsen, Mrs. Ole K., 508 Millauden St., New Orleans, La.
Porter, Mrs. J. L., New Orelans, La.
Reed, Mrs. Geo. L., Atlanta, Ga.
Street, Mrs. L. J., 871 Grosmeer Ave., Winnipeg, Canada.
Shoemaker, Mrs. Erma, Philadelphia, Pa.
Thomson, Mrs. H. F., 605 Buder Bldg., St. Louis, Mo.
Van Galder, Mrs. Florence T., Urbana, Ill.
Van Houten, Mrs. Esther, 4536 Wentworth Ave., Chicago, Ill.
Weathers, Mrs. H. C., Gainesville, Fla.
Wig, Mary B., Los Angeles, Calif.
Wright, Mrs. Neldien H., Jackson, Miss.
Zass, Mrs. W. W., Little Rock, Ark.

COLUMN TEST FUND NOW $10,702.50

FURTHER contributions to the Reinforced Concrete Column Test Fund are acknowledged as follows:

Previously acknowledged		$10,352.50
Received since Jan. 28		
National Slag Association, Cleveland	$50.00	
Smith & Brennan Concrete Pile Co., St. Louis	100.00	
Fruin-Colnon Construction Co., St. Louis	100.00	
General Materials Co., St. Louis	100.00	350.00
		$10,702.50

A. S. M. E.

NEXT month the American Society of Mechanical Engineers celebrates its 50th anniversary with an elaborate program of events at New York, Hoboken and Washington, (April 5-9), interpreting the social and economic influence of engineering on civilization.

Maxwell M. Upson, New York, and P. H. Bates, Washington, have been appointed representatives of the American Concrete Institute.

Discussions of papers and reports are scheduled. Please note at end of each contribution in *Proceedings* pages.

OLD FACES AND NEW

TIMELY COMMENT BY ARTHUR R. LORD

THE American Concrete Institute is a highly democratic body. Occasionally we meet a member who feels that the Board of Direction is a tight little group, only to be entered by means of nitroglycerine or TNT. But it is not so; the Institute, like every democratic assembly, frequently rewards long and faithful service by unceremonious dismissal. Such farewells cannot but be painful, disheartening, to those before whom the nominating committee, created annually by the Institute at large, opens a door labeled "Exit." The illusion of permanence arises from the dignified demeanor, the unhurried serenity of the *five latest living past presidents*, whose presence on the Board was intended to and does produce a desirable continuity, a tie between the past and the future. But mere members of the Board, such as I, are sufficiently transitory.

These lines are occasioned by the upheaval of 1930. No board member whose term expired this year (except the Treasurer*) was renominated, despite the excellence of their work. Four old faces are gone, four new faces will appear. In every instance the retiring directors have enjoyed the labor, and would like to have remained. The newcomers are, without exception, worthy selections, even judged by such a standard that no member should be elected to the Board who is not sound material for the Presidency. A turnover of four out of fifteen is positive assurance that effective workers in the Institute can trust the future for official recognition.

Dr. Hatt, thrice President of the Institute, retires by the automatic operation of the By-Laws.* Only by returning to the ranks, like Adams retiring from the White House to spend his remaining years in the Representative House, could the familiar face and wise counsel of the Doctor be retained (or in the unlikely event of one of the latest living Past-Presidents ceasing to be a member of the Institute). We who remain, in insecure tenantry, shall miss him greatly. Having held the helm during the lean war years, his term of official service is rivalled only by that of Uncle Ed Boyer, who retired as President principally to push Hatt off the Board! Uncle Ed brooks no competition on this matter of longevity of service!

John G. Ahlers, a director since 1926, is one of the veterans of the Board now unhappily displaced, happily to make way for new artisans. One of my first recommendations, as Chairman of the Advisory Committee, was to unload John, and others, who had long carried an entirely disproportional part of the work. He was marked by his *enthusiasm*. While other directors slept, he golfed in the morning dew, but his score at the business meetings was as high as that on the fairways and greens. During the few years by which my term has overlapped his, at least, he has never missed a meeting. We shall miss John, too, however heartily we may enjoy his worthy successor. Even the pencil with which

*The office of Treasurer, elective annually and that of Secretary, filled annually by Board appointment, are in practice for the last 10 years combined in one person on Board recommendation for administrative convenience—especially as the office of treasurer is not a salaried one and involves considerable detail. —EDITOR.

*"The officers shall be the President, two Vice-Presidents, six Directors (one from each geographical district), the Secretary and the Treasurer, who, with the five latest living Past-Presidents, who continue to be members, shall consititute the Board of Direction."—Article II, Sec. 1, BY-LAWS.

I write was furnished by him!

And what modern traveler shall undertake to equal R. J. Wig's record on the Board—not a perfect record, for he missed the last airplane that should have brought him to one meeting. From Lompoc to Cresco is a long way, even by air. He represented well, although adopted, the sons of the Golden West, including a goodly part of our territory west of the Mississippi. He allowed no admixtures in his loyalty to the Institute. His consistency was beyond improvement, his record on the Program Committee and elsewhere was one by which the entire membership profited.

Young members, new members of the Board, I, whom you collectively succeed, greet you! It shall be your pleasure henceforth to wait on table, replenish the fire and attend to other honorable tasks at the Fall Board meetings, tasks which I inherited three years ago. At least you can *divide* the labors among you, but I fear you shall lack that generous assistance of older members which has lightened my load to the vanishing point. The office of cub director is an agreeable one, for all the attendant duties. Uncle Ed will attend to your education in it, never fear.

And I, if I be spared, will go so far as to recommend each of you for an assignment in the Institute that may help to remove the danger of ennui or atrophy from your immediate future. You succeed men of proud accomplishments in every handsome trait of which a director should be master—enthusiasm, diligence, loyalty, comraderie, helpfulness. If you work hard you may even become a member of the exclusive Committee on the Weather, on which Ahlers and Hatt were long influential. On the Board of the American Concrete Institute, you should enjoy the very best of growing weather.

—

NATIONAL CONCRETE PRODUCTS ASSOCIATION

THE National Concrete Products Association held its 10th annual convention at the Roosevelt Hotel, New Orleans, February 10. D. R. Collins, first vice-president occupied the chair in the absence of the president, and later was elected president.

Mr. Collins addressed the meeting on the organization's past and possibilities for the future in cooperative work. D. F. Servey, secretary-treasurer of the Haydite Manufacturers Association, talked on the use of light weight aggregate in concrete and concrete products and showed stereopticon views of various phases of Haydite production and many examples of large construction projects involving concrete masonry units, shows the possibilities of light weight aggregates in extending the market for concrete products. W. D. M. Allan, manager, Cement Products Bureau, Portland Cement Association, discussed the future of some of the existing problems of the industry—the outstanding one being over-capacity. He expressed the opinion that the success of the individual manufacturer depends upon a capacity operation of the plant and that such capacity production could be marketed only by improved merchandising methods and increased sales activities. In view of the fact that approximately 80 per cent of all concrete masonry units are used in residence construction, the market must be extended into non-residential construction fields if the industry is to continue to grow. The fact that the decrease in concrete

masonry production during 1929 was not equal to the decrease in residential construction is attributed to the fact that many producers of concrete products were able to market their output in other than the residential construction field. Aside from the improvement of merchandising methods, Mr. Allan urged the Association to provide for investigations of weather resistance of concrete masonry, the performance of a series of wall strength tests, and a study of the sound and heat insulating properties of concrete masonry.

D. R. Collins described the operation of the cooperative selling organization formed by the Milwaukee concrete products manufacturers. In addition to President Collins other officers were elected as follows: First Vice-President, Austin Crabbs; Second Vice-President, A. G. Swanson; Secretary, Jack Franklin. At a special meeting held after adjournment of the regular meeting, it was decided to make a drive for membership among the larger and more important concrete products manufacturers, probably restricting the concentrated effort to the country's leading 250 producers. The object is to raise $15,000 to $20,000 a year to be spent for research and advertising.

CONCRETE DEMONSTRATORS TRAVEL BY TRUCK IN RURAL INDIA

FROM V. P. Noel-Paton, Bombay, India, comes a reprint of an article in the *Times of India*, Engineering Supplement, telling how a knowledge of concrete products is being taken to the doors of the rural population of India's United Provinces and of the Southern Punjab.

Two motor demonstration units have been organized—specially designed, aluminum painted bodies on Ford trucks, carrying roof and floor tile machines, with molds for pipes, vases, flag stones, balustrates, etc. A crew consists of a demonstrator in charge, four experienced workmen and driver. Along the way a tent-like shelter is set up and a demonstration made. The effort is as a sales stimulator, by Killick, Nixon & Co., Bombay, and their agents, Bird & Co., Lahore, Delhi and Cawnpore.

"I am confident" writes Mr. Noel-Paton, "that some (A. C. I.) members would have been amused to see one of our lorries stick in the middle of the River Tapti and then be drawn out by water buffaloes and about 30 coolies. It is our hope that a concrete bridge will span the river at the spot before many years are past."

LIEGE CONGRESS OF MINING, METALLURGY AND APPLIED GEOLOGY

Some months ago announcement was made that a committee had been formed under the auspices of the Association des Ingénieurs sortis de l'Ecole de Liége and of the Société Géologique de Belgique at Liége, for the purpose of organizing in 1930 an International Congress of Mining, Metallurgy and Applied Geology.

The Committee of Organization of the Sixth International Congress of Mining, Metallurgy and Applied Geology now gives notice of the arrangements in detail.

King Albert and the Belgian Government extend patronage. Meetings will be at Liége from Sunday, June 22, to Saturday, June 28, 1930. A circular* contains particulars concerning: the

*The Secretary's office (A. C. I.) will send one of the circulars to Institute members asking for it.

Honorary Committee and of the General Committee of Organization; rules of the Congress; list of subjects proposed for discussion; summary program of excursions and visits to works, and conditions of membership for individuals as well as corporations.

INVESTIGATION OF WATERPROOFING COMPOUNDS

THERE is now in progress at the Bureau of Standards an investigation of the effects of a representative number of the many commercial dampproofing and water-proofing compounds that are used in practice to decrease the permeability of concrete. Before the actual investigation of the compounds was started a study of the permeability of plain concrete, without admixtures or coatings, was necessary to determine the type of mixture, methods of fabricating, and the curing, etc., which were to be used in the specimens under investigation. To show the relative merits of the various admixtures and coatings, it was essential to develop a concrete that was permeable to a slight degree and then use this mix in all the specimens that contained the waterproofing compounds.

Specimens 4 inches thick were made using 12 mixes of concrete, ranging from 1:1:5 to a 1:4:6 mix and tested for permeability. The water-cement ratio and the size grading of the sand and gravel were varied for each of these mixes. The tests on these varied mixes showed that a mix of dry consistency was too permeable. but *a mix which was wet enough to be workable was practically impervious.** The medium flow between these two extremes, which allowed a small amount of water to pass through the specimen, could not be obtained by control of the water alone, so the thickness of the specimen was changed.

It was finally decided to use a specimen 2 in. thick, consisting of 1 part of cement, three parts of Potomac River sand, 6 parts of ¼ to ⅜ gravel, and a water-cement ratio of 1.175, as a standard. This mix is put into a cylinder mold 5 in. in diameter and bumped on the flow table instead of puddling or tamping.

After a 7-day curing period in the damp closet the specimens are ready for test. They are placed between two pipe flanges carrying rubber gaskets and tightened so there is no leakage around the edges. A water pressure of 20 pounds per sq. in. is then put upon the specimen, and the amount of water passing through it in a specified time is recorded. The permeability will be determined at various times up to one year, but the pressure on the specimens will be maintained at 20 pounds at all times.

*Aside from these italics, this announcement is from *Technical News Bulletin*, U. S. Bureau of Standards. The italicized statement should provoke comment. It is significant that the Bureau was at some pains to produce a permeable concrete and that *workable* mixes in great variety were "practically impervious."—EDITOR.

Members who wish to be sure of a complete bound volume (Vol. 26) after the issuance of the JOURNAL for June, 1930, may order while the reserve copies last at $6.00 per volume. The supply is limited.

IN CONSTANT REPAIR

(*A Conversation with Dr. Sam'l Johnson*)

Dr. Johnson: A man, Sir, should keep his Friendships in a state of Constant Repair.

The Author: And no less, Sir, his Information.

3—ON REDUCING

BY ARTHUR R. LORD

A high building at Dearborn and State
Is distressed by its great over-weight.
"I'd be lighter and cheaper,
And my happiness deeper,
Were my concrete of light aggregate."
—*Anon.*

TO IMPLY the ability to entertain this very human grief in a steel-and-concrete skyscraper is, perhaps, unduly imaginative and even weakly sentimental. But engineers have realized that old lady Skyscraper is getting heavy on her feet in these days, even if she is unable to complain. If she would be content not to hold her head quite so impossibly high, we should have less difficulty in reinforcing her insteps and in providing her with big enough shoes, while the bones in her lower limbs might be less gigantic and space consuming. And so we have decreed in a few instances that there shall be less substance—or rather *less heavy* substance—in her flesh and draperies. With a few of the new models built, we are now speculating as to the rejuvenated lady's prospect for health and longevity.

The old lady's case is unique in medical history, at least so far as I have discovered. In the brief space of twelve or fifteen months she does all her growing. After that tender age, no amount of dieting or setting up exercises—not even a vibrator—can reduce her avoirdupois by a pound! And she spends this first all-important formative period of her life in the almost exclusive society of contractors—general and sub! Her case may seem hopeless; but hold!

The secret of relief—and the responsibility—lies as usual with the engineer. While the contractor feeds the growing structure, the engineer *prescribes* the food and determines the result. If the engineer will heed the plea set forth so touchingly in my opening limerick, he may specify the use of lightweight aggregate and so relieve the situation. For long years this has been done in some part by the use of *cinder* concrete, concerning which we have already heard in the November NEWS LETTER. The latest popular relief is found in a material known as Haydite, a lightweight, clean, strong aggregate made by burning and crushing clay and shale. Used as fireproofing for the steel columns and girders and for the floor slabs, a truly impressive saving in dead load is realized and the reduced cost of the steel frame more than makes up for the rather high cost of the lightweight aggregate. I understand that trade competitors to Haydite are now nearing the marketing stage, with the possibility that the relief from over-weight may be even less expensive in the future.

The use of Haydite concrete involves new construction problems as well as new design considerations. This aggregate is lighter than water. Concrete made from it has always appealed to me as *concrete upside down*. You see a cartful approach on the runway and you think "What unusually stiff concrete for a skyscraper contractor to be using!" But wait! The coarse aggregate is on top, the mortar at the bottom, and the latter may shoot half

way across the panel when the cart is dumped. If you foolishly place the stiff upper concrete in a narrow joist you may have trouble in spading it into any proper consistency. Your cement finisher will have a new experience in trying to finish this gritty, non-plastic top material, without a mortar topping placed separately. The whole technique is certainly different—but who will tell us just how this new material may best be handled on the job to insure uniformly good results?

It is different too, in its physical characteristics. Haydite seems to have an unquenchable thirst for water and holds on to it with uncommon tenacity. Cylinders remain damp even though stored in air for long periods. What effect does this have on the curing of Haydite concrete? What part of the water that it sucks up so greedily, is effective as mixing water? How may we determine the real water-cement ratio of the concrete when this material is used?

"Haydite" is but a trade name. As made in different plants it is visibly different. Western Haydite, made of Danville (Illinois) shale is lighter, fluffier, more porous and more fragile —even though it seems to develop ample strength of concrete. Kansas City Haydite is heavier, darker, appears to contain more slag and is harder to crush. Other kilns have their distinguishing differences. In what degree are the properties—the concrete-making excellencies—of these different materials under a single family name known? What is the modulus of elasticity, the elastic deformation, the absorption and the adsorption, the permeability and the permanence under various exposures of concrete made from each?

While it may be said that weather resistance is not so important in skyscraper concrete today, who knows how soon concrete may be used extensively for the architectural exteriors of such buildings? And weather resistance is certainly a most vital property in the case of concrete blocks and roofing tiles, for which more Haydite is now used than for any other purpose. Not all of these are stuccoed or waterproofed, and it would be a shame if the excellent surface texture of this material must always be concealed by applied finishes to correct for its high permeability. Is not some means available to waterproof such a block without submerging its pleasing texture?

Western Haydite is the only material in this family, so far as I know, to be submitted to anything approaching exhaustive or adequate tests on which to judge its quality and by which to determine its manner of use. These tests (at Illinois) are not yet completed. From job tests and other "sketchy" information, we may judge that a 2000-lb. Haydite concrete will show a lower value of E_c (a higher value of n) than does ordinary concrete. To what extent should this difference be considered in our design formulas? It would seem that column vertical steel would take higher stresses than usual when encased in such concrete. What may we expect as to the initial stress in this steel, caused by the shrinkage of the concrete? What will be the extent and effect of the plastic flow of such concrete in the columns in lower stories of buildings?

The properties of Haydite concrete (including the basic one of weight) and its cost will vary with the use of sand or fine Haydite for fine aggregate. What are the economic factors that

must be balanced and what do they tell the designing engineer? Shall we use sand or fine Haydite for buildings, taking into account the range of heights? How does this substitution affect all the other properties? Does the strength of the Haydite, from any source, limit the ultimate strength of the concrete made from it? To what extent do the undoubtedly superior acoustical properties of Haydite concrete improve the corresponding properties of the buildings in which such concrete is used?

If lightweight aggregates propose to mingle socially with all the thoroughly tested and long used materials of ordinary concrete it would seem that all of them—not one alone—should make haste to establish their scientific credentials. We need such materials, but we are certainly justified in holding back from their general use until the engineer knows more about them than this habitual enquirer has been able to learn thus far. But I am most anxious to be informed and most grateful for further help in keeping my information in a state of constant repair.

NEW MEMBERS

Sixty-seven applications for membership in the month of January have been approved by the Board of Direction from the following:(*denotes supporting member)

American Concrete Pipe Co. of Texas, Magnolia Bldg., Dallas, Texas. (R. A. Foley, V. P. & Gen. Mgr.)

American Vibrolithic Corp., 109 8th St., Des Moines, Ia. (H. L. Tillson, Chief Engr.)

Barney, William Joshua, 110 W. 40th St., New York, N. Y.

Bartlett & Snow Co., The C. O., 6200 Harvard Ave., Cleveland, Ohio. (L. R. Wilson)

Burke, John A., New England Concrete Pipe Corp., 79 Milk St., Boston, Mass.

Burrell, H. P., MacArthur Concrete Pile Corp., 19 W. 44th. St., New York, N. Y.

Chandhuri, L., 1 Barada Mitter Lane, Chambarar, Calcutta, India.

Cooper, Nelson, 103 E. 125th St., New York, N. Y.

Cosgrove, Frank H., Light & Power, Caixa do Correio "a", Sao Paulo, Brazil.

Cross, Earl H., Box D. D., Chicago, Ill.

"Danalith" A/S, 1 Gyldenlovesgade, Copenhagen V. Denmark.

Doyle, Frank P., 309 W. 93rd St., New York, N. Y.

Driggers, Clyde, 4525 39th Place, Long Island City, N. Y.

Ernst, Walter S., Box 75, Cowan, Tenn.

Everist, Inc., L. G., 2100 E. 4th St., Sioux City, Ia. (J. C. Boswell)

Farrell, John J., 184 Mamaroneck Rd., White Plains, N. Y.

Federici, Albert, Paterson, N. J.

Gillon, Frank, 470 East 161 St., New York, N. Y.

Grisi, Adolfo P., Calle 5 No. 1380, La Plata, Argentina.

Heilbronner, L. C., Caixa Postal 2947, Sao Paulo, Brazil.

Holdsworth Patents, Inc., 250 W. 57th St., New York, N. Y. (Harry Holdsworth)

Hooks, James H., Alberene Stone Co., 153 West 23rd St., New York, N. Y.

Horner & Wyatt, 470 Board of Trade Bldg., Kansas City, Mo. (Roy M. Wyatt)

Hunt, Thomas D., 536 County City Bldg., Seattle, Wash.

Johnson, E., c/o Francisco & Jacobus, 511 Fifth Ave., New York, N. Y.

Jones, F. S., Chas. Pfizer Co., 11 Bartlett St., Brooklyn, N. Y.

Kaufman, David M., Francisco & Jacobus, 511 5th Ave., New York, N. Y.

Koenitzer, L. H., Kansas State Agricultural College, Box 217, Manhattan, Kansas.

Knopel, Herbert J., Warner Co., 1518 Walnut St., Philadelphia, Pa.

Lincoln, R. W., 5007 8th Ave., Seattle, Wash.

Lind, Theodore, 929 78th St., Brooklyn, N. Y.

Linnell, Frank A., Hartford Concrete Co., 97 Vine St., Hartford, Conn.

Lockwood Greene Engineers, Inc. Wrigley Bldg., Chicago, Ill. (Dan Adams)

Lockwood Greene Engineers, Inc., 100 East 42nd St., New York, N. Y. (R. V. Banta)

Lockwood Greene Engineers, Inc., 24 Federal St., Boston, Mass. (H. E. Cousins)

Malmrot, Hakan, 33 W. Grand Ave., Chicago, Ill.

*MANITOWOC PORTLAND CEMENT CO., Manitowoc, Wisc. (E. J. Maguire, Vice-Pres. & Treas.)

Miller, Lewis B., 6511 Morgan Ave., Cleveland, Ohio.

Milwaukee Concrete Products Cooperative Assoc., 87 27th St., Milwaukee, Wisc. (D. R. Collins)

Mission Staff & Stone Co., 1512 Knowles St., Los Angeles, Calif. (J. M. McGrath)

Missouri, University of, School of Mines and Metallurgy, Rolla, Mo. (John H. Dougherty, Libm.)

Moore, L. B., Box 246, Balboa Heights, Canal Zone.

Mueser, William H., 342 Madison Ave., Room 1126 A., New York, N. Y.

Nowell, Jr., Joseph G., c/o Stone & Webster Engineering Corp., P. O. Box 202, Bloomfield, N. J.

Olympian Stone Co., 6401 Seaview Ave., Seattle, Wash. (Leo Swartz)

Queensland Main Roads Commission, Brisbane, Australia. (J. E. England)

Parker, Frank P., 119 W. 57th St., New York, N. Y.

Rackle & Sons Co., The George, Box 1778, Station D, Cleveland, Ohio. (E. E. Rackle, Pres.)

Reniger Construction Co., 127 N. Cedar St., Lansing, Mich. (M. H. Reniger)

Ritterbush Bros., 209 North 7th St., Bismarck, N. Dakota. (Robert A. Ritterbush)

Roscoe, Ralph E., Bessemer Cement Corp., 1100 City Bank Bldg., Youngstown, Ohio.

Schulze, John C., Croton-on-Hudson, New York.

Seattle, City Engineer's Department, City County Bldg., Seattle, Wash.

Seeliger, Joachim Eberhart, 655 Hazelwood Ave., Apt. 310, Detroit, Mich.

Snare Corp., Frederick, 114 Liberty St., New York, N. Y. (Randall Creamer)

Standard Portland Cement Co., P. O. Box 6, Painesville, Ohio. (Erie J. Ochs, Supt.)

Tappan, K. H., c/o Alcoa Power Co., Ltd., Kenogami, Que., Canada.

Thomas Cast Stone Co., Ernest, 841 Pacific St., Portland, Oregon. (Ernest Thomas, Pres.)

Van Raalte, S., Burke, Horwood & White, 229 Yonge St., Toronto, Ont., Canada.

Votaw, Carl, School of Architecture, Oklahoma A. & M. College, Stillwater, Okla.

Weber, Lester N., The Sisalkraft Co., Room 212-M, 205 W. Wacker Drive, Chicago, Ill.

Webster, Daniel T., 41 E. 42nd St., New York, N. Y.

Wilcox, Fred C., 626 Esplanade, Pelham Manor, N. Y.

Williamson, E., 7754 Saginaw Ave., Chicago, Ill.

Wininger, Edward, 78 26th St., Jackson Heights, L. I., N. Y.

Wyatt, W. Kirk, Reading Terminal, Philadelphia, Pa.

Young, T. D., The Pettyjohn Co., 215 E. 7th St., Mt. Carmel, Ill.

THE CAST STONE INSTITUTE

The Cast Stone Institute which met in New Orleans February 11 and 12, has 17 member manufacturers; 15 of them were represented at the meetings by one or more individuals; 7 other cast stone manufacturers were present and a number of visitors.

Having cooperated with the American Concrete Institute in the development of the Concrete Institute's Tentative Specifications for Cast Stone, the Cast Stone Institute will make it a part of its program to see that these specifications are generally used.

Activities of the following year will include an effort at greatly increased membership and the assembling of data in regard to cast stone manufacture, studies in individual plants and correlation of the information based on the physical qualities of the stone manufactured in the plants studied. Based on this information it is proposed to draft recommendations for the benefit of all members, and to encourage laboratory research to improve present manufacturing technique. Special attention will be given to grading of aggregates, proportions of mixes, quantity of mixing water, and extent of curing.

The Cast Stone Institute will also study waterproofing based on the kinds used by manufacturers, digest published data on waterproofing materials and practices, and encourage laboratory research on the effect of waterproofing materials upon absorption, upon strength, and the duration of the effectiveness of waterproofing materials. There will also be a study of mortars in relation to cast stone.

The following officers were elected: President, C. Van de Bogart; Vice Presidents, Wm. Paul Eddy and Herman Frauenfelder; Secretary, L. A. Falco; Treasurer, O. L. Formigli; Directors 2 year term, M. A. Arnold, B. D. Harter, Ernest Wiedemann, E. E. Rackle; Directors 1 year term, J. F. Norris and A. D. Donald.

Papers and Reports—In this Issue

Proceedings American Concrete Institute

Vol. 26—Pages 513-602

PRESIDENT'S ADDRESS 514
By EDWARD D. BOYER

GOOD PRACTICE IN CONCRETE FLOOR FINISH 520
Report of Committee 802, JOHN G. AHLERS, Chairman—with discussion

DISCUSSION OF "PERMISSIBLE OPENINGS IN CONSTRUCTION" 550

THE DESIGN AND OPERATION OF CENTRAL MIXING PLANTS —A SYMPOSIUM 551
By MILES N. CLAIR, H. F. THOMSON, N. D. CROWLEY, FRED C. WILCOX, A. W. MUNSELL

DISCUSSION OF "PROPOSED CONSTRUCTION SPECIFICATIONS FOR CONCRETE WORK ON ORDINARY BUILDINGS" 580

DISCUSSION OF "PORTLAND CEMENT STUCCO FINISHES" ... 595

DISCUSSION OF "VARIATIONS IN STANDARD PORTLAND CEMENTS" 597

Discussion of the contributions in the following 90 pages is scheduled for publication in the* JOURNAL *for September 1930 and should be available not later than August 1.

President's Address

At the 26th Annual Convention

BY EDWARD D. BOYER

A QUARTER-CENTURY ago there was organized in Indianapolis an association through which its members sought to share their rather incomplete knowledge of a relatively new construction material and increase that knowledge, so that they might do their own work more confidently and more efficiently, and better serve the engineering profession and the general public.

That was the National Association of Cement Users which with a change of name seventeen years ago became the American Concrete Institute.

For a number of years the Institute struggled for existence. Its members were few, its treasury depleted, and it was having great difficulty in paying for the printing of its annual *Proceedings*.

In 1914 Mr. Wason became president, followed by Dr. Hatt and Mr. Turner and with their efforts and persistent work the Institute took on a new lease of life. In 1920 the membership was 426; today it is about 2750 and I trust that before another ten years this membership will be where it should be—well over 10,000. Today we have a very substantial balance in the treasury and our bills are promptly paid.

As I pass on the office of president to my successor I would like to tell you why I think the material concrete can be made to serve the engineering profession very much better than it has ever done—and that without any apology for what it has done in the past.

Concrete appeals to the imagination. Its development has been quick and romantic. It has seemed a tractable, a willing servant of mankind. Plastic, accommodating, by the special

magic of its ingredients—a manner of magic, that even our wisest chemists do not yet fully understand—this plastic, accommodating conglomeration, in a short time solidifies to a veritable rock-of-ages. Now because of facility of accommodation, seeming ease of manipulation, this pliant service to whatever might be required, everyone dabbled with it. All over the land was soon heard the roar and grind of crushers disintegrating the hills into convenient particles and of mixers stirring those particles with water and the mysterious gray powder. Could anything be more simple? Engineers and farmers, municipalities and states, every back-yard putterer with a block machine—all doing their share in remolding rocky landscapes into serviceable concrete.

But as always, there are those who will not let things go on haphazard. They are always asking "why" and "how" and "what happens." They are forever bedeviled with a violent urge to know. Their very sleep is disturbed by visions of a better way.

Here was concrete—strong, willing, cheap, as simple as mud. But they had to take it into the laboratory and weigh and measure and test, and go out on the job and pester everybody about better methods, more exact methods, more constant and unwavering methods. The concrete industry has never had the relaxation of smoking jacket and slippers.

Now, most of these strivers after a better way with concrete were members of the American Concrete Institute. I am ready to resist any contradiction of the statement, that the American Concrete Institute is the hardest working of all engineering associations. Its annual conventions have worked eight to ten hours a day—they sit up until well after midnight to discuss and to adopt forty odd amendments in an effort to create the best possible, most workable and economically serviceable building code under which reinforced concrete construction may come into new eras of human service.

But I am getting ahead of my story!

From the very first there were those with that foresight which revealed new worlds to be conquered in the application of concrete to construction. They were not satisfied with empirical formulas for the design of structures nor with empirical mixes for

making concrete. They were not satisfied with the brute massiveness of masonry construction nor with the often lusterless gray of the surfaces of those masses. They foresaw that more material than is needed means waste and that less than is needed means disaster.

They foresaw that with a powder so potent as cement, rule-of-thumb methods of proportioning it to the aggregates left much to be desired. They foresaw that structural sections might be refined from needlessly large and awkward dimensions to thin, serviceable lines that would combine grace, economy, and a saving of billions of dollars to the building public while presenting a more beautiful appearance to the public eye.

They foresaw that concrete is, after all, a synthetic stone, always responding wonderfully to increased accuracy of control; that its dominant characteristics should be imparted by the particles of aggregate—limitless possibilities of varied color and texture.

These foreseeing minds have been the leaven of the American Concrete Institute. In them, through them, research has prospered. There always has been dominant the attitude that facts should show the way.

The result is this: Never has a construction material been so intently, so intensively studied. It is doubtful if any material has been the subject of so much research.

If the American Concrete Institute had been organized for promotional effort instead of for highly professional and scientific study, it could not have built a promotional effort on a more solid and enduring foundation. For after all, there is no promotion more convincing than the naked honesty of fact. If ever we can find out how best to do a piece of work for enduring results we can be sure that those results are in themselves the best promotional effort.

In recent years thirty odd committees of the organization have studied good design and construction practice in relation to the special application or fields of interest to which they were assigned.

Hundreds of individuals—certainly numbering many of the best minds in engineering thought—have set down so that all

might apply them, the lessons they have learned in their work with concrete.

Annually, these committee reports and papers are presented to the American Concrete Institute; they are studied and discussed and must pass muster before the combined experience of a constantly growing membership—a membership more than six times as great as it was eight years ago. It is such connotation of progress that the American Concrete Institute published in its annual volumes of *Proceedings*. The 25th of these volumes has been added to this row of books—not yet a "five foot shelf" comprising the sum of human knowledge, but a three foot shelf in which is the record of the steps by which concrete design, construction and manufacture have come up from haphazard guesswork to well-calculated precision.

I have referred to vast studies and minute research. The American Concrete Institute has not done these things. It has no laboratory; it has no employed field force. Nevertheless the American Concrete Institute is the technical mouthpiece of the industry in which its members are all seekers after progress. The American Concrete Institute is a piece of machinery of correlation, a forum for discussion, a bureau for dissemination. In short, the object of the American Concrete Institute is "to provide a comradeship in finding the best ways to do concrete work of all kinds and in spreading that knowledge."

And gentlemen, from a thoroughly human standpoint, it is a wonderful comradeship. To feel and to understand the spirit that actuates the leaders in this field of thought is to begin to understand the nature of the progress that has been made in our knowledge of concrete and of the technique of its successful application.

Within this comradeship there has been a friendly but insistent matching of the dictates of laboratory research to the necessities of field methods. The meticulous care of the laboratory cannot be set up in the hurly-burly of job conditions, but the constant effort of the Institute has been to accept no unworkable formulas. Refinements that are not also economies—practical and workable economies in the far-sighted and best sense—are certainly not worthwhile refinements.

Within the forum of the Institute the research man has had to see his results weighed in the balances of practice. The big and effective work of our organization is to coordinate theory and practice.

The whole program of the Institute is built up carefully to reconcile the technical and scientific aspects of good concreting with the practical considerations of everyday work—translating the conclusions of the laboratory into field and shop practice.

We are beginning to see the results!

For eight or ten years there has been more and more emphasis placed on a higher degree of quality control—methods at first greeted by many practical minds as impossible of attainment on the job.

The Institute has not been satisfied merely to preach better concrete, honestly facing and carefully studying every defect for its cause, but it has now attained to those riper and more gratifying years in which it is year by year recording the successful results of practicing what it has preached. Nor must it be imagined that we have attained any final goal—far from it.

I should be remiss if I did not especially note outstanding new enterprises of the Institute. There comes a time when the lack of new information is an apparent obstacle to progress. There are doubtless many gaps in our knowledge which we should try to close but we do not always discover them promptly. The new committee work of the Institute is being directed to serve the double purpose of determining the nature of those blind spots and the means to correct them.

Notable among the new committee undertakings of the last year is the program of the committee on Reinforced Concrete Column Investigation, which the Chairman, Mr. Slater, has described to you. The purpose of this study of columns is to establish the fundamental relationships between the load, elastic properties and ultimate strength as affected by such factors as quality of concrete, size of column, amount and quality of longitudinal and lateral reinforcement, rate and method of applying load, and effect of continuous loads over long periods of time. This information will cost, according to present estimates, thirty-five to forty thousand dollars, involving as it does the making and testing of more than 500 columns.

The American Concrete Institute is sponsoring this effort and considerably more than half the needed funds, including the direct and indirect contributions of Lehigh University and the University of Illinois, are assured. It is believed that the knowledge to be gained will be of such value in reinforced concrete design as to make the cost insignificant. The funding effort is still in progress and I feel it is my duty to urge that further contributions be made promptly as an investment toward more rational and therefore more economical practice.

The column tests are devised to give us new information. Yet we are frequently impressed by the fact that we are not making use of all the information now available. There must be a constant effort to reduce to definite conclusions and put into common practice the knowledge fruits of past experience. Our knowledge is recorded piecemeal; it is scattered, uncorrelated, undigested. We must bring it together in one basket and sort out of it those items of fact which are most significant in our daily work. The Institute is undertaking such an enterprise as a part of its present committee program.

Still another work—not at all spectacular but having in it, even in its small beginnings, the possibilities of great helpfulness to every member of this Institute and to many outside this Institute—is the new JOURNAL section of *Abstracts* of current literature significant in the field of cement and concrete. An able committee is cooperating with the Secretary's office in determining the scope, the character and the detail of the work. With many abstractors in this country and abroad scanning every contribution to the literature of our field and extracting the essence of each such contribution for the pages of your JOURNAL, there is made available to all of us as never before the full moving panorama of progressive experience as it relates to our special work.

We have progressed so far in learning about concrete that we have unlearned much of what was once our store of knowledge.

While we have adopted standard specifications and recommended practice for doing many things in concrete design, construction and manufacture, we know very well that we are at but a stage of the journey—that we are going to amend and improve these standards.

That is one of the fine things in the motive force of the Institute—its members know there is so much still to learn. But they have the satisfaction that comes with a feeling that within the organization they are in the right place to observe activities on the frontiers of progress in their field and are always alert to the prospects of new achievement.

This year we have entered upon a new era. We have ceased publishing the yearly book of *Proceedings*; we have scrapped all the old committees, and in their place we give to the members a monthly JOURNAL, new committees with Author-Chairmen and critic members with a promise of increased interest.

In relinquishing the presidency to my successor I am proud of the fact that for all these years I have had an official connection with your Institute, and I look forward to a future for the Institute which shall make our present progress seem but the first step of its march toward the perfection of an art.

Good Practice in Concrete Floor Finish

Report of Committee 802, Concrete Floor Finish

JOHN G. AHLERS, CHAIRMAN

The committee was asked to report on good practice in finishing floors in the light of recent experience with methods better than those in general use. It is commonly said that floor finishing is the poorest job in concrete building construction—often because, as the committee clearly says, the floors are skimped. The present report will serve as a basis for a new recommended practice to be reported after time for thorough discussion of methods here described. Committee 802 has five members, four of whom approve this report—one remaining silent.—Editor.

The assignment of this committee was to prepare a report on good practice in finishing portland cement concrete floors, with special reference to workmanship and the time, amount and kind of manipulation recommended for the final results.

The committee has reviewed old methods, specifications and recommended practice in the light of present-day knowledge, with a view to making this report the basis of new recommended practice.

In order to show clearly and properly emphasize the causes of difficulties of the past, and to outline the advantages of different procedure, it is necessary to review the methods that have been used in the past.

Poor concrete floors result more often from improper manipulation of materials than from the use of inferior materials.

Inferior floors are caused by:

Use of too much mixing water.

Too much manipulation (screeding, floating, troweling) of the wet mix, bringing fine particles and laitance to the surface.

Too high a percentage of fine particles (passing the fifty mesh) in the sand.

Improper curing.

Good floors can be produced by:

Limiting the mixing water from 4½ to 5 gallons per sack of cement, and increasing workability by longer mixing.

Using only coarse sand.

Using not less than 1½ parts of coarse aggregate.

Not floating or troweling the surface when it is wet and sloppy.

Delaying the finishing operation after screeding until all surface water has disappeared (from 30 to 45 minutes).

Proper curing for not less than 7 days.

GENERAL DISCUSSION

The committee feels that the foregoing statements and recommendations are justified by results obtained in the past and by facts gathered in the last few years in research, field tests, and practical experience.

The new principles developed in concrete making apply to concrete floor finishes as well as to structures generally. Durability and service are first objects; for the time being strength is secondary. It is believed that when durability is the object of design, strength will be ample.

The committee recognizes that the dominating influence in buying concrete floors is cost. Too often building prices are reduced to meet competition by the mere expedient of relaxing the specifications for floors. For instance, bids are taken on a building with considerable floor area. Prices are found to be eight or ten per cent in advance of the money available for construction. Various items in the bids are scrutinized, and it is found that the price of the floors may be reduced and still maintain other desirable features of the structure. Specifications for the floor finish are therefore altered so that they will cost 12 cents per square foot instead of 18 cents. When the building is completed, the 12-cent floors are subjected to the traffic for which better floors were first designed. Eighteen-cent floors

cannot be built for 12 cents; neither will 12-cent floors give anywhere near the same service as higher priced floors.

The attitude of the contractor and his men is important. Often there is a lack of interest on the contractor's part in this assumed minor part of the construction of a building. He may have employed mechanics with no fundamental knowledge of how to produce good floors. Since, in general, the greatest difficulty is one of workmanship, lack of interest by those responsible, may give poor results when the best of materials are used. Costs need not then be increased by more work. It needs merely intelligent work. The stress needs to be on manipulation.

COMPARISON OF MANIPULATIONS

First, let us consider the old 1:2 specification. The principal ingredients are cement, sand and water. As a rule, the sand used for floor topping is the same as that employed in the regular building operations. No account is taken of the effects of fine materials, particularly the percentage passing the 50 mesh screen, on the finished product. Sand and cement are mixed with an amount of water that gives a consistency which will work well under the trowel. Mortar is placed on the base, struck off and floated. Troweling operations start almost immediately. Aside from the effect of fine material in the sand and the use of too much mixing water, untimely and excessive troweling at this particular period is the one operation that produces the most unsatisfactory results in the surface.

When a steel trowel is applied to a soft mushy topping, water, cement and fine materials are immediately drawn to the surface, where they should not be. The fines assist in producing "a nice looking" finish, but they have little or no wear value. Troweling operations usually continue until the surface is stiff enough to produce a smooth even finish composed largely of these fine particles.

Another practice extensively used is in dusting cement or cement and sand on the surface after the topping has been screeded, and before it has hardened. Generally, this practice aggravates the difficulties already mentioned. In effect, the contractor recognizes that an excess of water will delay the time of finishing the work. As a result, the water-cement ratio is lowered

by placing dry cement or a mixture of cement and dry sand on the surface to absorb the excess. When the dusted-on material becomes wet, the surface is floated and troweled. However, the good results of lowering the water ratio are offset by fine material. Such a practice is conducive to crazing or so-called map cracks. It is suggested that where the dust coat method is to be used, a mixture of cement and coarse sand be applied. It is possible to produce a satisfactory floor where the coarser material is properly floated into the surface with careful workmanship.

A high water ratio for a mortar top, coupled with the presence of fine material drawn to the surface by troweling, results in a soft scum or film on the surface of the floor with a very high coefficient of shrinkage and a low resistance to wear. There must be a new conception of toppings. Mortars, as generally understood, should not be employed. Essentially there are required definite proportions of cement, sand (graded somewhat coarser than normally used) and stone or gravel consisting of particles slightly larger than the maximum sized grains in the sand. The mixture should be placed and finished, as described in another part of this report.

The last operation in floor finish construction is that of curing. The value of proper curing has been established by all investigators of cement and concrete, and applies with greater force to floor finish more than any other form of concrete construction. If the usual specification for covering with damp sand is ignored, and the concrete permitted to dry at the surface before the chemical reaction between water and cement has progressed far enough, inferior floor finishes invariably result. Improper curing results in unnecessary crazing due to the rapid shrinkage, at the surface, and in floors that will dust under service.

Whether the topping is placed independently and after the base has hardened, or monolithically with the base, the procedure normally followed is parallel to that just described. When placed monolithically with the base, the topping is usually mixed just as it would be for placing on a hardened base. If care is not exercised, excess water used in the concrete for the structural slab tends to increase the water-cement ratio of the mix for the finish as well as to incorporate in the surface all of the fines and

impurities that are on the top of the structural slab. Here again, excessive manipulation with a steel trowel will produce a defective floor finish. It is therefore recommended that where the topping is placed monolithically with the base, the structural concrete be placed as dry as possible and with the least possible water in the topping mixture. Excellent results may also be obtained by allowing the structural slab to harden for eight or ten hours, after which the topping is placed.

RECOMMENDATIONS

It is not the intention of the committee to imply that good floors have not been constructed in the past. As a matter of fact, when the millions of square feet of floor surfaces now in use are considered, it is evident that a remarkably small percentage are really giving cause for dissatisfaction. However, the general practice followed throughout the country is not giving anywhere near the results that can be obtained, and better floor finishes should be produced at a very slight increase in cost.

The committee recognizes the difficulty of changing practice of long standing, yet sufficient evidence exists to prove that the recommendations offered are worthy of consideration by this Institute and should be incorporated in standard specifications. In these recommendations we embody the same fundamentals that now control the making and placing of concrete for other uses.

The committee presents for consideration a specification which not only embodies provision for the mixture of cement, water, fine and coarse aggregates, but also a procedure in operation. The mixture consists of 1 part of cement to 1 part of coarse grained sand which shall contain not to exceed 10% of fines passing a 50 mesh screen, and 1½ to 2 parts of gravel or crushed stone ranging in size from ¼ to ⅜ in. To this shall be added 4½ to 5 gallons of water per 94-lb. sack of cement. Such a mixture will be somewhat harsh and unworkable when considered from the standpoint of structural concrete, or the old mortar top mixes. However, the method of placing and the manipulations necessary to produce a smooth hard finish are such that these proportions can be compacted and worked into the desired finish.

Basically, the principle of producing workability is the same in this case as in structural concrete. There must be enough cement paste completely to surround the aggregate particles. The question, therefore, is one of mechanical operation in order to produce the desired finish.

Floor finishes can be mixed with less fine aggregate than can structural concrete. There are two reasons for this requirement: First, it is desired to expose or have retained at the surface as much of the extremely hard coarse aggregate as is possible so that it will take most of the wear; second, in compacting the floor finish by rolling, troweling or otherwise to eliminate the tendency of the fine aggregate working to the surface. If there is an excess of fine material in the mixture, it will be difficult to keep the coarser particles at the surface.

It is recommended that the proportions for the floor topping mixture be designed for each specific job by the trial method. Trial batches in the proportion of 1 part of cement to 1 part of coarse grained sand and 2 parts of coarse aggregate graded from ¼ to ⅜ in. should be mixed with the specified amount of water. If it is found impossible to place this mix on the slab under the procedure outlined, a slight adjustment may be made in the volume of the coarse aggregate. The proportion of the coarse material may be adjusted down, but under no circumstances should the coarse aggregate be less than 1½ parts, nor the water increased above 5 gallons per sack of cement.

After these proportions have been mixed for not less than 2 minutes, they should be placed on the structural slab and screeded into position. The topping is then floated, bringing to the top a small amount of mortar for finishing purposes. The floor is then allowed to stand for 30 to 45 minutes, depending upon weather conditions, before troweling operations start. In this time the topping will have stiffened sufficiently to prevent fine particles from being brought to the sufrace by troweling. Final troweling may then proceed without damaging the surface. The more hard troweling at this particular time, the denser will be the slab and the more coarse aggregate at the surface. Hard troweling has the effect of forcing the coarse particles of aggregate into the

mass and covering them with just enough mortar to produce a smooth finish.

The mix and manipulations above specified will no doubt draw criticism from the mechanics. It will take more muscular effort to spread and screed such a mix than is required under the old specifications. There will also be criticism of the delayed finishing operation because the surface will become fairly hard and rather difficult to work with a trowel. If this practice is not followed, however, the old difficulty of bringing up too much fine material to the surface and the over-working of moist and wet spots will produce a floor with a high percentage of laitance and soft spots.

As soon as the concrete has hardened sufficiently to prevent pitting, it should be wetted down and covered with damp sand or a specially prepared paper than may be sealed to prevent evaporation. Where sand is used, it should be kept wet for not less than ten days.

The Committee recognizes that the type of construction proposed will cost somewhat more than the usual cheaper types of floors. The increase in cost is more in additional labor, effort and care than in the materials. The increased wearing resistance of the floor finish by the expenditure of this additional labor is worth many times the cost to the owner of the building, who is entitled to as high quality finish as can be obtained under this procedure. It is further recommended that contracts for floors be placed in the hands of competent contractors and mechanics.

The construction of highly ornamented floors is a separate item and is not covered in this report. We refer particularly to the construction of terrazzo floors or terrazzo and concrete tile. The painting or staining of floors should also be considered separately, as well as the use of coloring matter in the topping. Practice for this kind of work should also be covered in future reports.

The occupancy of a building should be studied and the floors designed to fit traffic conditions. Two specifications are given: one covering the construction of heavy and light duty types of floors, and one on the dust coat finish. By varying the size of aggregate and the method of finishing, the first specification may be changed to apply to heavy duty or light duty floors.

As an added precaution, special attention should be paid to the manner in which all details are cared for in the specification for "dust-on" floors. Such a type of construction should be placed by skilled and competent organizations, under rigid inspection. These floors can be built to withstand all types of traffic, but it must be recognized that ordinary abrasion will, within a reasonable time, wear through the surface and expose the underlying concrete to the same action for which the finish was designed. If the structural concrete is sound it may take many years to wear through the surface, even under extremely heavy traffic.

PROPOSED RECOMMENDED PRACTICE FOR HEAVY DUTY FLOOR FINISH

WITH NOTES FOR LIGHT DUTY FLOOR FINISH

Submitted by Committee 802 for Discussion

1. BASE SLAB

THE surface of the structural base slab shall be finished reasonably true and struck off at a level approximately one inch below the required finish grade

As soon as the condition of the concrete base permits, and before it has fully hardened, all dirt, laitance and loose aggregate shall be removed from the surface with a wire broom, which shall leave the coarse aggregate slightly exposed, or the surface otherwise roughened to improve bond with the topping.

When it is impossible to remove laitance and roughen the slab by brooming, the surface shall be cleaned and prepared for bond by chipping after the base has hardened.

Just prior to placing the finish, the base slab shall be thoroughly cleaned by scrubbing, to the satisfaction of the engineer.

(*Note:* Notes appearing after articles 2, 3, 5 and 6 pertain to wearing courses that are to be finished by grinding. Each note provides the basis of revision of the paragraph preceding it when considering the finish of floors by grinding.)

2—AGGREGATES

Both fine and coarse aggregates shall be used in the finish. Fine aggregate shall consist of clean, hard sand or crushed stone screenings free from dust, clay, loam or vegetable matter. All particles shall pass a ¼-inch sieve and shall be graded from fine to coarse with the coarse particles predominating. Not more than 3 per cent shall pass a 100 mesh, and not more than 10 per cent shall pass a 50 mesh sieve.

Coarse aggregate shall consist of clean, hard pea gravel, or crushed stone, free from dust, clay, loam or vegetable matter and from coatings which will tend to weaken the bond. It shall contain no soft, flat or elongated fragments, and shall be graded from ¼ to ⅜-in.

Note: For light duty floor finish the coarse aggregate shall be graded from ⅛ to ¼-in. (passing a ¼-in. screen but retained in a ⅛-in. screen).

All aggregate shall be selected with care. Coarse aggregate shall be of an approved character, and samples of proposed material shall be submitted to the engineer for approval prior to use.

Note: When the topping is to be finished by grinding, the coarse aggregate shall be hard, tough, crushed stone graded as recommended for terrazzo.

3—MIXTURE

The mixture shall be 1 part portland cement, 1 part fine aggregate and 2 parts coarse aggregate by volume. This nominal mix may be slightly varied, depending upon the local conditions, and as the engineer may direct. If the aggregate is very coarse, the gravel or stone should be reduced to 1½ parts. In no case shall the volume of the coarse material be more than twice the volume of the fine.

The mixture shall be determined by the engineer and once established shall not be changed except upon his written order.

Not more than 5 gallons of mixing water including the moisture in the aggregates shall be used for each sack of portland cement in the mixture.

Note: When the topping is to be finished by grinding, no sand shall be used. One part of cement by volume shall be mixed with 3 parts crushed stone.

4—CONSISTENCY

The concrete shall be of the driest consistency possible to work with a sawing motion of the strike-off board, or straightedge. Changes in consistency shall be obtained by adjusting the proportions of fine and coarse aggregate within the limits specified. In no case shall the specified amount of mixing water be exceeded.

5—PLACING AND COMPACTING

The base slab shall be thoroughly wetted just prior to the placing of the finish, but there shall be no pools of water left standing on the wetted surface. A thin coat of neat cement grout shall be broomed into the surface of the slab for a short distance ahead of the topping. The wearing course shall be applied immediately before the grout has hardened, and brought to the established grade with a straightedge.

Note: When the surface is to be finished by grinding, the wearing course shall be compacted with rollers or vibrators. Rollers shall be of sufficient weight to compact the concrete thoroughly. When the engineer may direct, coarse aggregate shall be uniformly scattered over the surface while rolling is in progress.

5a—PLACING AND COMPACTING (LIGHT DUTY FLOOR FINISH)*

The concrete topping shall be deposited on the base within 45 minutes after the concrete base is in place and before the base has appreciably hardened.

*Use paragraph 5a in lieu of 5 for light duty floor finish.

6—Finishing by troweling

After striking off the wearing course to the established grade, it shall be compacted with a wood float. The surface shall be tested with a straightedge to detect high and low spots which shall be eliminated. Floating shall be followed by steel troweling after the concrete has hardened sufficiently to prevent excess fine material from working to the surface. The finish shall be brought to a smooth surface free from defects and blemishes. No dry cement or a mixture of dry cement and sand shall be sprinkled directly on the surface of the wearing course to absorb moisture or to stiffen the mix. After the concrete has further hardened additional troweling may be required. This shall be done as may be directed by the engineer.

Note: Surfaces to be finished by grinding shall be swept with soft brooms after rolling to remove any water and surplus cement paste that may be brought to the surface. The wearing course shall then be floated and once lightly troweled, but no attempt shall be made to remove all trowel marks.

7—Finishing by grinding

After the wearing course has hardened sufficiently to prevent dislodgment of aggregate particles, it shall be ground down with an approved type of grinding machine shod with free, rapid cutting carborundum stones to expose the coarse aggregate. The floor shall be kept wet during the grinding process. All material ground off shall be removed with a squeegee and the floor shall be flushed with water.

Air holes, pits and other blemishes shall then be filled with a thin grout composed of one part of No. 80 grain carborundum grit and one part of portland cement. This grout shall be spread over the surface and worked into the pits with a steel straightedge, after which the grout shall be rubbed into the floor surface with the grinding machine.

After all patch fillers have hardened for seven days the floor surface shall receive a second or final grinding to remove the film and to give the finish a polish. It shall then be thoroughly washed and all surplus material removed.

7a—Finishing by grinding (light duty floor finish)*

This paragraph to be used in lieu of paragraph 6 when finish by grinding is desired.

After the topping is struck off to a true and even surface it shall be thoroughly compacted with a wood float until all depressions and irregularities are eliminated. The surface shall then be once lightly troweled and allowed to harden. During the hardening period the surface shall be protected as required in Article 8.

After the wearing course has hardened sufficiently to prevent dislodgment of aggregate particles, it shall be ground down with an approved type of grinding machine shod with free, rapid cutting carborundum stones. Only a light cut shall be taken with the grinder, and care shall be observed to produce a finish of uniform appearance. The floor shall be kept wet during the grind-

*Use paragraph 7a in lieu of 7 for light duty floor finish.

ing process. All material ground off shall be removed with a squeegee and the floor shall be flushed with water.

Air holes, pits and other blemishes shall then be filled with a thin grout composed of neat cement paste. This grout shall be spread over the area and worked into the floor surface with the grinding machine.

After all patch fillers have hardened, the floor surface shall receive a second or final grinding to remove the film. It shall then be thoroughly washed and all surplus material removed.

8—CURING AMD PROTECTION

All freshly placed concrete shall be protected from the elements and from all defacement due to building operations. The contractor shall provide and use when necessary tarpaulins completely to cover or enclose all freshly finished concrete.

If at any time in the progress of the work the temperature is, or in the opinion of the engineer will, within twenty-four (24) hours, drop to 40° F. the water and aggregate shall be heated and precautions taken to protect the work from freezing for at least five (5) days.

As soon as the concrete has hardened to prevent damage thereby, it shall be covered with at least one (1) inch of wet sand, or other covering satisfactory to the engineer, and shall be kept continually wet by sprinkling with water for at least ten (10) days.

PROPOSED RECOMMENDED PRACTICE FOR DUSTED-ON FLOOR FINISH

1—WHERE USED

Dusted-on floor finish shall be used only where the structural concrete has been produced and placed under absolute control of the water-cement ratio and where the water-cement ratio of the structural concrete does not exceed 7½ gals. of water per bag of cement.

Dusted-on floor finish shall not be permitted on structural concrete where the fine aggregate contains more than 5 per cent passing 100 mesh, or more than 15 per cent passing 50 mesh, nor where the fine aggregate contains dust, clay, loam or vegetable matter. It is assumed, furthermore, that the coarse aggregate in the structural concrete consists of hard, clean, coarse particles, free from dust, clay, loam or vegetable matter, and from coatings which will tend to weaken the topping.

2—MATERIALS

The mixture to be used for spreading on the structural slab shall consist of standard portland cement, and any of the following:

(*A*) Screened, sharp, clean, coarse particles taken from sand, meeting the above specifications, or

(*B*) Metallic aggregates approved by the engineer, or

(*C*) Ground quartz, or other dense rock screenings between the sizes $\frac{1}{32}$-in. to ¼-in.

All aggregates shall be selected with care, and approved by the

engineer before use. Sample of the proposed material shall be submitted to the engineer for approval before using.

3—MIXTURE

The mixture to be spread on the screeded off concrete shall be one part of portland cement to one or one and a half parts of fine aggregate, as selected by the engineer.

These materials shall be mixed dry in a mortar box, or in an approved mixing machine.

The material, after mixing, shall be bagged for the purpose of determining the quantity used on the structural slab.

4—CONSISTENCY OF STRUCTURAL SLAB

The dry-mixed materials shall not be placed on the structural slab until it has been allowed to settle after screeding and all surface water has been removed by a darby or other approved means.

5—PLACING AND COMPACTING

When the structural slab is in condition so that all surface water has disappeared, or been removed, the dry-mixed material shall be applied at the rate of one bag to each one hundred square feet of floor area.

The dry material after spreading, shall be floated off and worked into the slab. Floating operation shall be stopped as soon as the dry material becomes sloppy and wet, and floating withheld until the surface moisture has disappeared.

6—FINISHING BY TROWELING

After the first floating the floor surface shall stand without working from 20 to 30 minutes, depending on weather conditions. The floor area shall then be compacted with a wood float. The surface shall then be tested with a straightedge to detect high and low spots which shall be eliminated. Floating shall be followed by steel troweling after the concrete has hardened sufficiently to prevent excess fine material from working to the surface. The finish shall be brought to a smooth surface free from defects and blemishes. After the concrete has further hardened additional troweling may be required. This shall be done as may be directed by the engineer.

7—FINISHING BY GRINDING

If a ground surface is desired, the dry material may be merely floated and all inequality evened out by proper floating and only one slight troweling thereafter.

After the surface and the structural slab have hardened sufficiently to prevent dislodgment of aggregate particles, it shall then be ground down with an approved type of grinding machine, shod with free, rapid cutting carborundum stones to expose the coarse aggregate. The floor shall be kept wet during the grinding process. All material ground off shall be removed with a squeegee and the surface flushed with water.

Where required air holes, pits and other blemishes shall then be filled with a thin grout composed of one part of No. 80 grain carborundum grit and one part of portland cement. This grout shall be spread over the surface and

worked into the pits with a steel straightedge, after which the grout shall be rubbed into the floor surface with the grinding machine.

After all patch fillers have hardened for seven days the floor surface shall receive a second or final grinding to remove the film and to give the finish a polish. It shall then be thoroughly washed and all surplus material removed.

DISCUSSION—EFFECT OF MATERIALS AND MANIPULATION UPON QUALITY OF FINISH*

BY W. E. HART†

IT IS the object of this discussion with its series of pictures from photographs to show present methods in concrete floor finish and a recommended method for best results. Floor finishes generally have been made with a mortar topping. It is proposed that specifications provide for a mixture of one part cement, one part sand, and two parts coarse aggregate. Such a specification has been used extensively in some sections of the country, and is not an experiment.

Studies in laboratory and field by many investigators have developed new principles in concrete making. The application of these principles is most needed in the finish of floors because of the service expected of them. The application of the water-cement ratio law to the construction of floors shows it is practical and economical to change the grading of floor toppings so as to produce durability and resistance to traffic.

Most floors are now made with a one-inch mortar topping composed of one part of cement and two parts of sand. Too often the grading of the sand is not taken into consideration. Too high a percentage of fine material in such a mortar top contributes to a soft, absorbent finish with excessive shrinkage. Sand should be graded from zero to ¼-in., with not more than 10 per cent passing the No. 50 screen. The coarse particles of the sand should predominate, thus reducing the shrinkage factor to a minimum.

Fig. 1 shows the sand that was used in the first demonstration; Fig. 2, the proper condition for the base. Prior to the hardening of the base, it should be scrubbed with a stiff broom so as to expose the aggregate, thus producing a surface that will promote bond of top to base.

*Presented at the 26th Annual Convention.

†Secretary Committee 802; Manager Structural and Technical Bureau, Portland Cement Association.

FIG. 1—SAND USED IN DEMONSTRATION

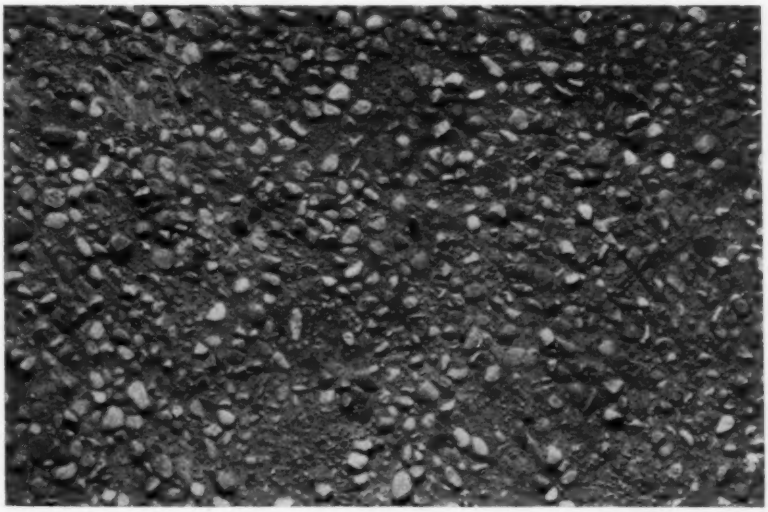


FIG. 2—A GOOD BASE ADDS TO THE STABILITY OF THE FLOOR

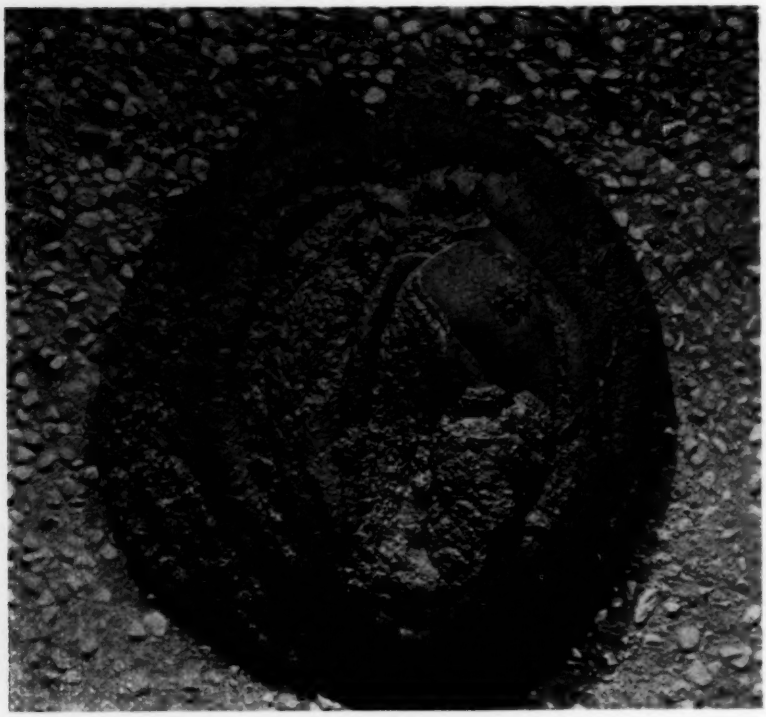


FIG. 3—A 1:2 MORTAR TOPPING BEFORE STRIKING OFF

Fig. 3 shows the mortar mixture on the base. To the one part of cement and two parts of sand were added approximately 5½ gal. of water, giving a consistency like that normally used in such work.

From this point on the methods used in placing and finishing the topping determine whether a good or poor finish will result. The usual practice is to screed the mix into place and then float to a true surface. Two operations then follow: The final finish may be produced with a steel trowel, or the surface may be dusted with cement or a mixture of fine sand and cement, after which it is troweled.

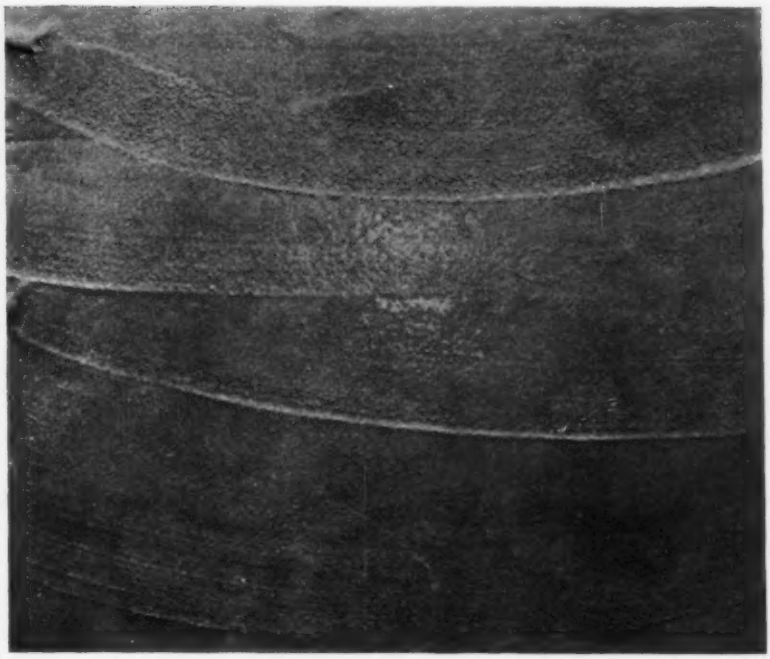


FIG. 4—FLOATING THE TOPPING

Fig. 4 shows the topping floated. Fig. 5 shows the topping covered with a dust coat composed of cement and fine sand, as used quite extensively throughout the country, and contributing largely to existing dissatisfaction with floor finishes.

The placing of a dust coat on the top of a floor finish has been considered a concession to workmanship. Such a dust coat absorbs excess water in the topping and permits the finishing operation to proceed without delay. It may be considered as an admission on the part of the contractor that excessive water has been used in the topping. The application of a steel trowel to so wet a mix brings cement and fine material to the surface, producing a soft, absorbent top, and one tending to craze and dust under traffic. It is suggested that where a dust-on type of finish is to be employed, instead of using cement and fine sand, that

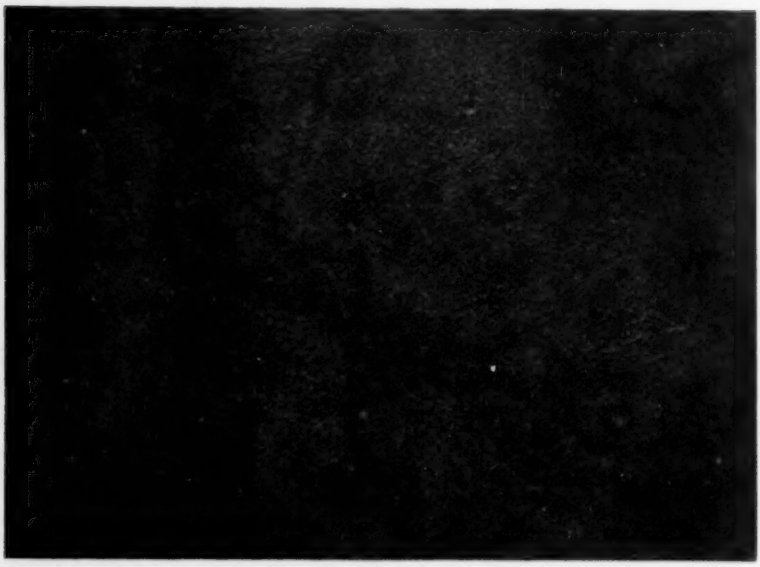


FIG. 5—THE MORTAR TOP COVERED WITH A DUST COAT OF CEMENT AND FINE SAND

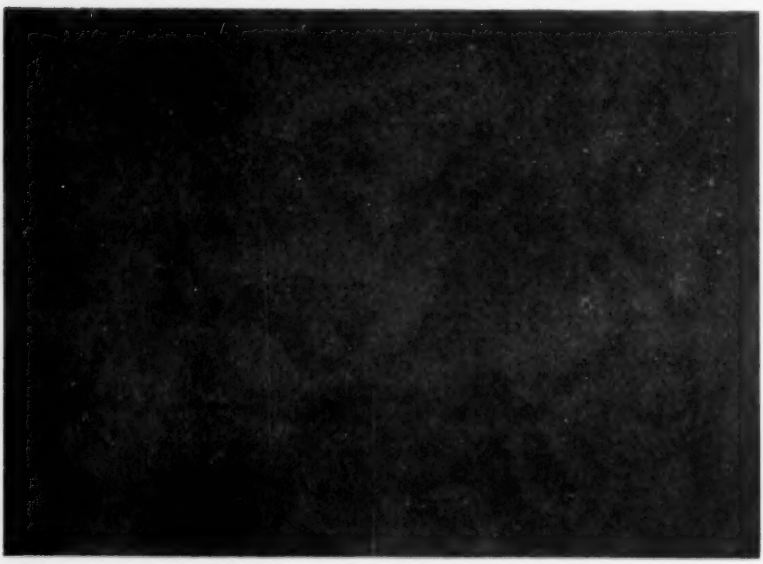


FIG. 6—FINISHED TOPPING

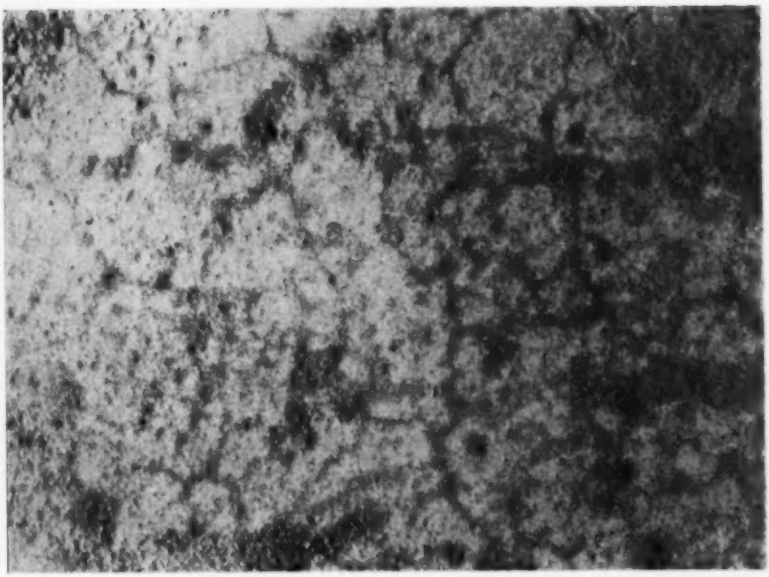


FIG. 7—DUSTING OF FINE MATERIALS ON A FLOOR FINISH TENDS TO STIMULATE CRAZING

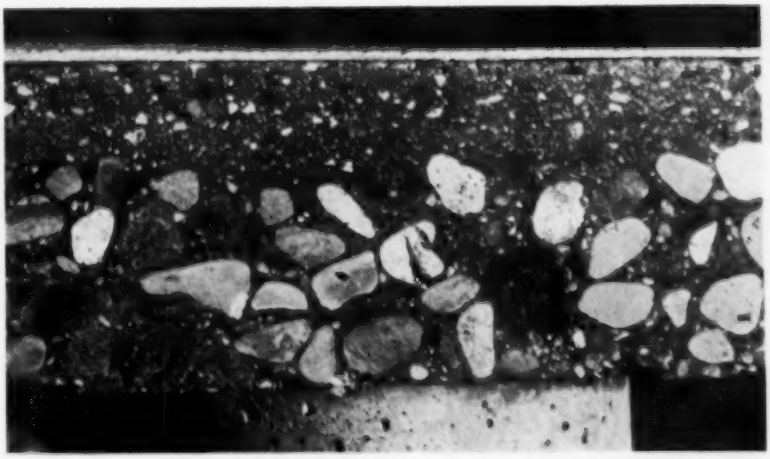


FIG. 8—SECTIONAL VIEW CUT THROUGH THE SLAB

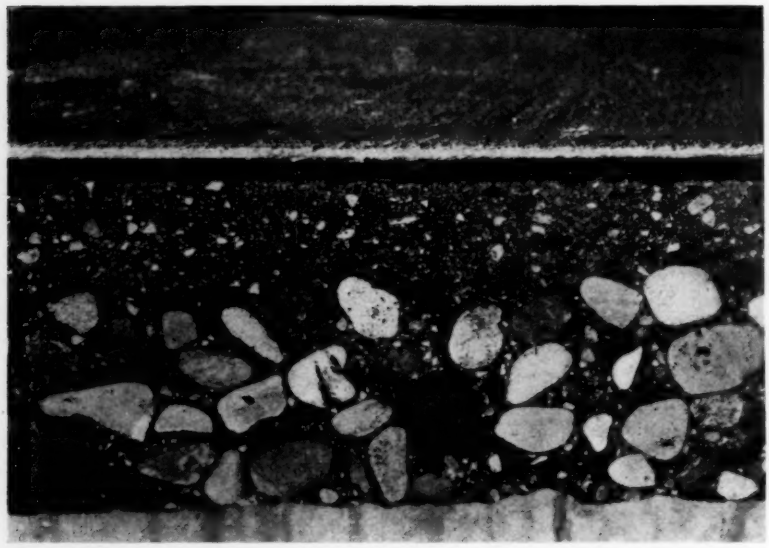


FIG. 9—SECTION SHOWING SOFT SURFACE REMOVED—1/8-IN. MATERIAL THAT USUALLY CAUSES DUSTING

only the coarser particles and a large percentage of coarse aggregate graded from 1/8 to 1/4-in. be added to the cement and applied to the surface. Then the final finishing of the slab should be delayed until all water has disappeared. It is true that this method makes for a cheap type of floor, but too often, through over-troweling and the presence of excessive fine materials in the sand, this cheapness is offset by trouble that follows when the floor is put into service.

Fig. 6 shows the finished topping. Fig. 7 shows the condition of the surface after about 10 days, especially illustrating the crazing that has occurred in the topping in this short time.

Fig. 8 is a sectional view of the slab showing the base and the topping. The dark line near the top was produced by removing with a carborundum stone that portion of the top that is composed of a soft absorbent material. This is approximately 1/8 in. thick, and represents the portion of the floor that is expected to take abrasion.

Fig. 9 is a view of the same section but slightly above, so as to show the depth of the mortar on the surface. Note that rubbing was continued until particles of sand began to show.

This illustrates the effect of over-manipulation of the finish and the disastrous results that usually follow. The materials may have been of the best, but through over-manipulation such fines as exist in the mixture are brought to the surface where they should not be and coarse particles have been forced below the surface. This picture also illustrates why some floors have soft, absorbent spots which tend to dust and wear under normal traffic.

The recommendation of the Committee for floor finishes that are to be subjected to either light or heavy duty is to incorporate coarse aggregate in the topping. A definite procedure is outlined for the manipulation of the mixture which will prevent fine materials from being drawn to the surface. Such a procedure will leave on the top a high percentage of coarse aggregate that will withstand abrasion. In the author's opinion the only difference in cost between this type of floor and the mortar mix is the cost of the additional coarse aggregate in the finish. Either way the mixtures work about the same under the float, except that the coarse aggregate mix has a little more stability than the straight 1:2 mortar top. This slight difference in cost may be entirely eliminated when you consider the extra time necessary to finish the mortar top. Certainly maintenance on the recommended type of floor will be much less than on the mortar topping.

The mix for the recommended type of finish is composed of one part of cement, one part of coarse grained sand, and two parts of coarse aggregate graded from $\frac{1}{8}$ to $\frac{3}{8}$ in., with all particles passing the $\frac{3}{8}$-in. screen. To this mixture is added not to exceed 5 gal. of water per bag of cement, including the amount of moisture in the aggregates. The grading of the coarse aggregate may be varied slightly to facilitate placing, but in no case shall the ratio of the volume of fine to coarse be less than 1:1½. The coarse aggregate may be composed of fine pebbles or crushed rock, both of a hard, durable character.

Fig. 10 shows the sand and gravel used for this topping. Fig. 11 shows the same sand with crushed rock instead of pea gravel.

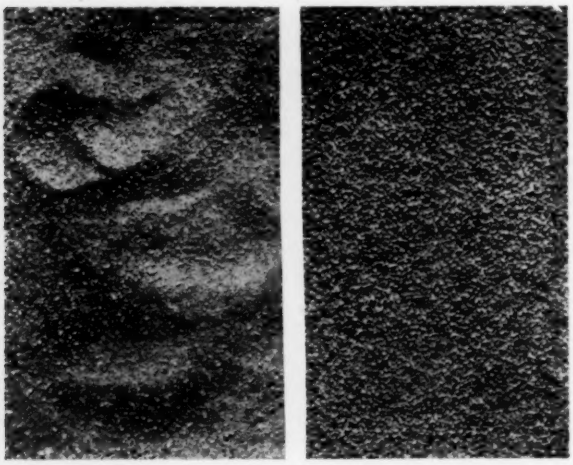


FIG. 10—SAND AND GRAVEL USED IN MAKING COARSE AGGREGATE TOPPING

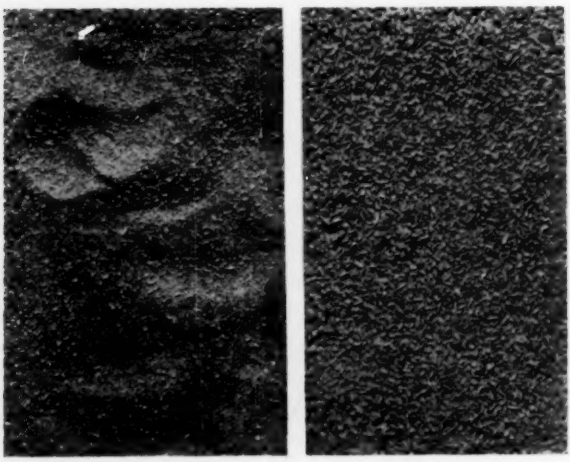


FIG. 11—SAME GRADING OF MATERIAL AS FIG. 10 EXCEPT THAT CRUSHED STONE MAY BE USED INSTEAD OF GRAVEL

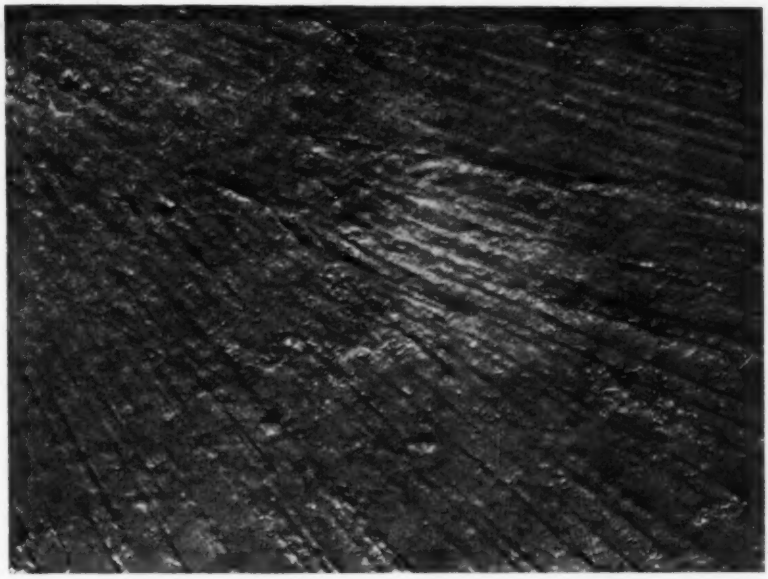


FIG. 12—PREPARATION OF BASE BEFORE IT HAS HARDENED

Fig. 12 shows the base after it has been placed but before it is dry. Fig. 13 shows the base slab ready to receive the topping. Note that by brushing, some of the coarse aggregate is exposed to facilitate bond between the topping and the base.

Fig. 14 shows a mixture of one part of cement, one part of sand with the fine particles removed, and two parts of pea gravel ranging in size from $\frac{1}{8}$ to $\frac{1}{4}$ in. with a small percentage of the $\frac{3}{8}$ in. These aggregates have been mixed with 5 gallons of water. Here, a word of caution. It has been found that by adding more than $5\frac{1}{2}$ gallons of water a very unworkable concrete is produced. One pint of excess water tends to destroy the proper consistency. As the picture shows, the mixture has the appearance of being very dry and unworkable.

Fig. 15 shows the consistency of the mix. It will be seen from this illustration that the workability is practically the same as that in the mortar mix except that the coarse aggregate gives this mix greater stability under the float. It is also interesting to

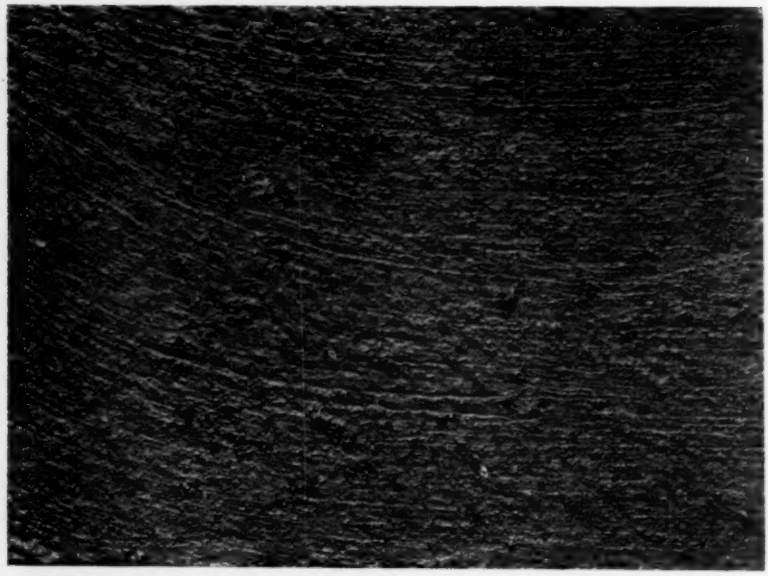


FIG. 13—APPEARANCE OF THE BASE AFTER HARDENING AND FINISHING

note that the slump for the mortar mix was approximately 7 in., and for this mix it did not exceed 1 in. The slump test is not here a true indication of comparative workability of the two mixes.

Fig. 16 shows the striking off of the top. It is interesting to note that the strike board tended to cut off an even amount of the topping and roll it ahead as easily as cutting off the same amount of material from the mortar top.

Fig. 17 shows the condition of the surface after it has been floated. From this point on manipulation is important. After the topping has been floated to a true, it is left undisturbed for 30 to 45 minutes, depending upon weather conditions. The topping should not be touched until all water has disappeared from the surface. Furthermore, a dust coat on this type of floor finish will completely defeat the purpose of the revised specification.

Fig. 18 shows the appearance of the slab after 45 minutes. The water has disappeared and the slab is now ready to receive

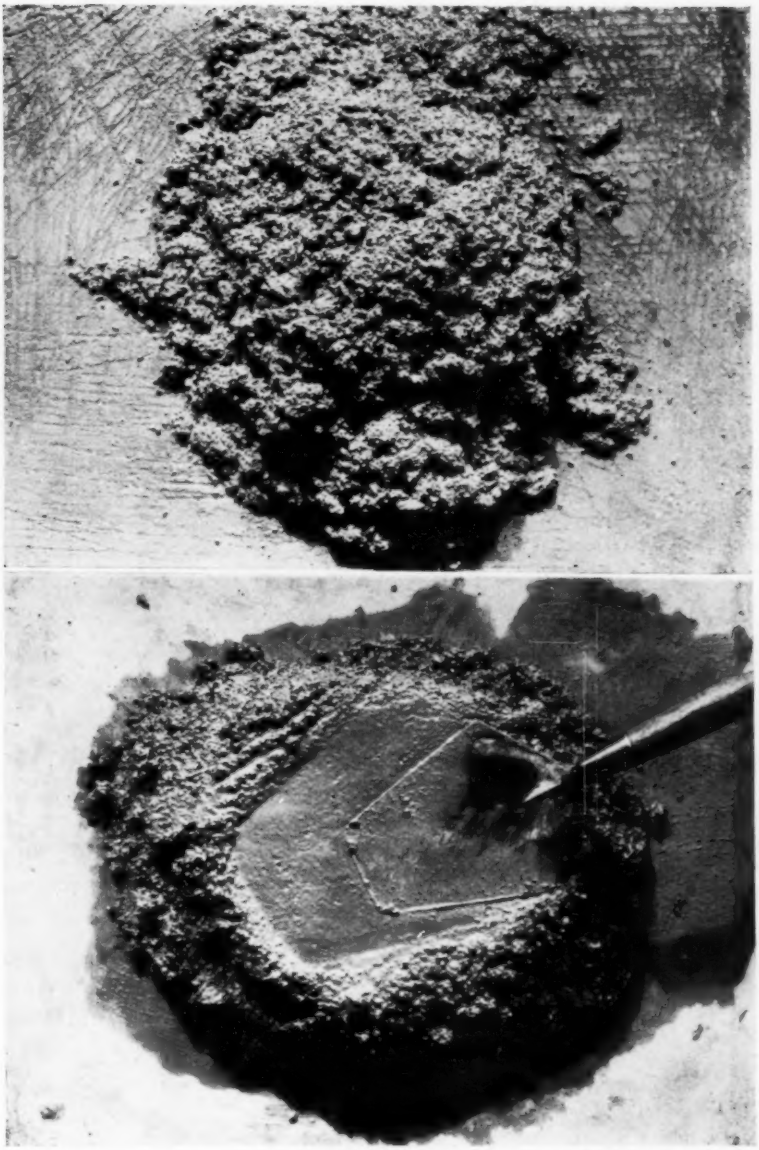


FIG. 14—COARSE AGGREGATE TOPPING BEFORE STRIKING OFF

FIG. 15—THIS PHOTOGRAPH ILLUSTRATES THE CONSISTENCY OF THE MIX WITH SUFFICIENT MORTAR PRESENT TO PRODUCE PROPER FINISH

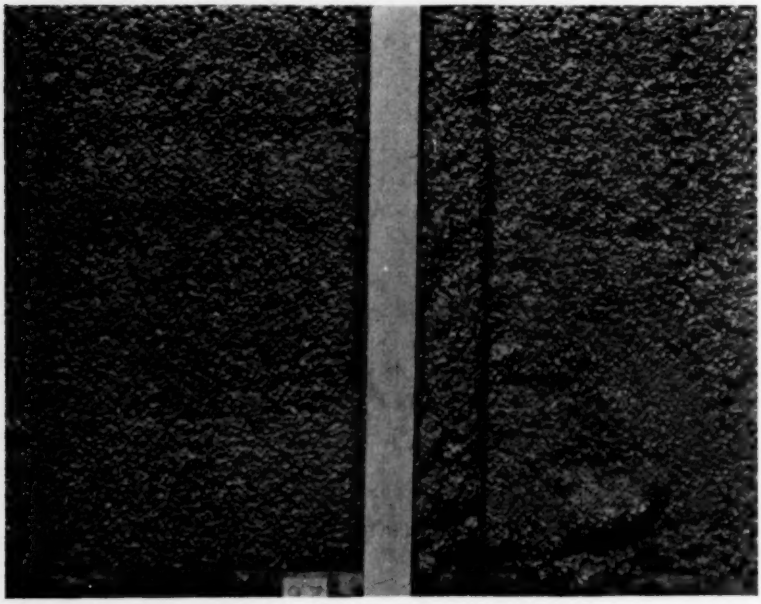


FIG. 16—STRIKING OFF THE TOPPING

the final finish. The reason for delaying the final finish is that a steel trowel may now be placed on the slab without drawing fine materials to the surface. During the 45-minute period the hardening action has set in and there has been a tightening of the surface so as to prevent the drawing of cement and fine materials to the top. The steel also serves to "point up" the surface by pressing down into the mass all particles of aggregate, but not below the surface.

Fig. 19 shows clearly that the theory advanced for this specification is practical. This picture was taken 15 hours after the final finish had been made. It shows conclusively that a large percentage of the coarse aggregate has been retained at the surface of the floor and covered with a very thin film of cement and other fine materials.

Fig. 20 is a sectional view cut from this slab. It shows the mass of aggregate in the topping and the amount of coarse

FIG. 17—APPEARANCE OF THE SLAB AFTER FLOATING

FIG. 18—APPEARANCE OF THE SLAB 45 MINUTES AFTER FLOATING. THE WATER SHEEN HAS DISAPPEARED

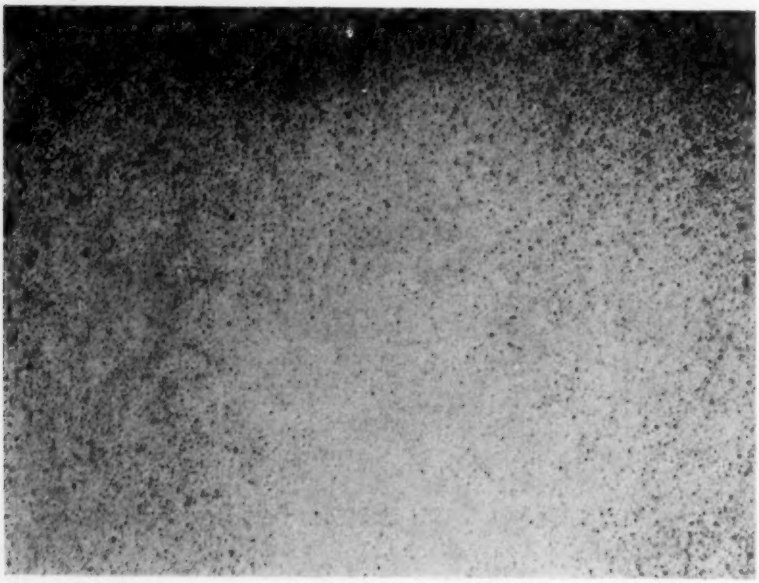


FIG. 19—APPEARANCE OF THE TOPPING 15 HOURS AFTER FINISHING. NOTE THE PRESENCE OF AGGREGATE IN THE SURFACE

aggregate that is in the surface. It is obvious, by comparing this with the 1:2 mortar top, that this method will produce a type of floor finish that will offer greater resistance to any traffic placed upon it. Fig. 21 is an enlarged view of the same sectional piece of concrete.

The conclusions to be drawn from this series of photographs should be more or less obvious. Mortar toppings generally have given satisfactory service. There are cases where the floors have dusted or become stained or broken up under traffic. In some cases chemical action of some sort has aided in this disintegration. It is not the intention to condemn the work that has been done in the past, but to propose a type of construction less likely to be unsatisfactory. In the proposed new specification the coarse aggregate will greatly reduce volume changes in the finished floor. The method of finish keeps the coarse aggregate where it will resist traffic. It therefore seems reasonable that we should

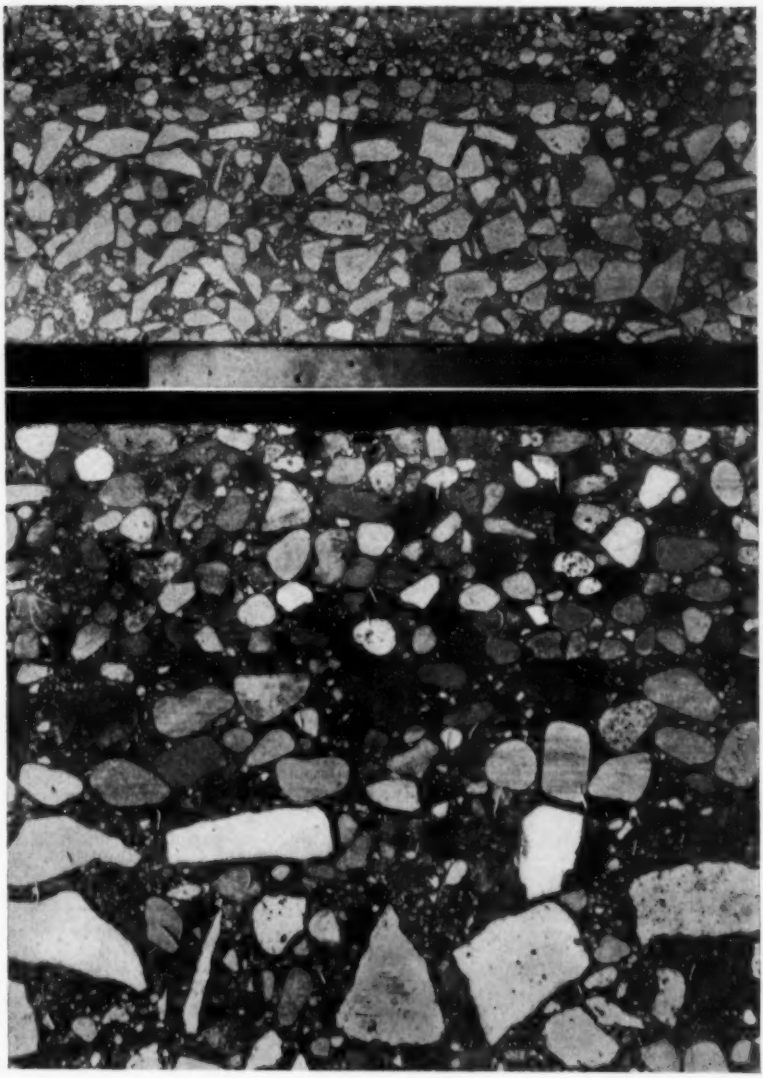


FIG. 20—SECTIONAL VIEW OF THE SLAB. COARSE AGGREGATE IS AT THE SURFACE TO TAKE THE WEAR, WITH NO FINE MATERIAL PRESENT

FIG. 21—AN ENLARGED VIEW OF THE TOPPING SHOWING THE POSITION OF THE AGGREGATE IN THE SURFACE

recommend this new type of floor finish, particularly as it does not add greatly to the cost of the floor and tends to eliminate chances for excessive maintenance costs.

FURTHER CONVENTION DISCUSSION

John G. Ahlers: Here are tabulated the total labor and material costs for a piece of floor placed under this specification a few days ago. It shows a net cost of slightly over seven cents per square foot, very much less than we thought would be the cost of this type of floor finish. The superintendent on this work was instructed to place this section of floor under this specification and was very reluctant to start as he was afraid he could not do a very satisfactory job with the water content so low.

	Area	*Quantity*	*Total Cost*		*Sq. Ft. Cost*
Cement	3500 sq. ft.	13.8 Bags	$69.00		$.02
Sand	3500 sq. ft.	6.8 Yds.	13.60		.004
Grit	3500 sq. ft.	6.8 Yds.	22.10		.0064
Cement Labor	3500 sq. ft.	10 men 3 hrs. 30 hrs. @ $1.17	35.10		.01
Cement Mason	3500 sq. ft.	43 hrs. @ 1.65	71.85	87.80	.025
		8½ hrs. @ 1.87½	15.95		
Overtime	Bonus	6 hrs. @ 1.65	9.90	12.75	.0036
		1½ hrs. @ 1.87½	2.85		
Labor Foreman	3500 sq. ft.	3 hrs. @ 1.50	4.50		.0013

No allowance for tools, supplies, plant rental, power, field overhead or profit.

From personal inspection while the floor was placed, we found, however, that it was possible to mix the finish and place it with a water content of exactly five gallons per bag of cement. It is believed that one reason for such a low amount of water was the mixing of the topping for not less than two minutes; this gave a very plastic and workable material even with the large amount of grit. This item of time of mixing should be further stressed in a specification.

On this particular work we happened to have two foremen working with their finishing tools and they both expressed their satisfaction with the mixture and the ability to handle it under the trowel. It is very important that the specification be such that practical men will live up to it as otherwise it is quite useless.

A Member: When you wet down and applied neat cement paste, you have practically destroyed what suction there is in the cold concrete slab. When the topping is put down without careful watering and neat cement paste, the suction in the concrete slab seems to draw water and paste from the topping into the slab and forms a satisfactory bond. Quite generally when the most precautions were taken we had the least satisfactory floors.

Readers are referred to the JOURNAL *for September, 1930 (Vol. 27, No. 1) for further discussion which may develop. Such discussion should reach the Secretary by August 1, 1930.*

Discussion of the report of Committee 306

"Permissible Openings in Construction"*

DISCUSSION BY A. S. WOODLE, JR.†

This suggested basis for specification covering the important question of permissible location of holes in concrete floors and beams seems to be complete except that no mention seems to be made of columns, which should also be included.‡

The writer would also suggest that more emphasis be placed on the undesirability of cutting holes in the flanges of beams or at any other point in the structure where there are heavy concentrations of direct stress. Theoretical analysis seems to prove that the presence of even a small hole in a flat plate subjected to uniform tensile stress increases the unit stress at the edges of such a hole to three times the average (see Appendix to Morley's Strength of Materials), so that it would seem wise to emphasize the desirability of not reducing highly stressed sections by holes, etc., except as a last resort; and where the holes are necessary the design should be made so that the average stress in the diminished flange should be very substantially less than the design unit stress.

*Report by Albert Smith, Author-Chairman Committee 306, Journal of the American Concrete Institute, November, 1929, *Proceedings*, Vol. 26, p. 24.

†Baldwin Locomotive Works, Philadelphia.

‡The report was presented as a partial, progress report only.—Editor.

The Design and Operation of Central Mixing Plants—A Symposium

BY MEMBERS OF COMMITTEE 603

Committee 603, Frank I. Ginsberg, Chairman, assigned to prepare a report on the design and operation of central mixing plants, found its time too short to prepare the usual formal report. The new industry of central plant production of concrete is growing and changing so rapidly that individual ideas yet need much threshing out. The first contribution of the Committee toward "covering" its assignment is in five brief papers by as many members of the committee: Miles N. Clair, H. F. Thomson, A. W. Munsell, N. D. Crowley and Fred C. Wilcox. These were presented at the 26th annual convention, February, 1930. In Mr. Ginsberg's absence, Mr. Thomson introduced the committee's contributions to the program. As reported here they will form the basis of a committee report later. In its preparation the committee welcomes further, full discussion. —EDITOR.

Comments on the Design and Operation of Ready-Mixed Concrete Plants

BY MILES N. CLAIR*

READY-MIXED concrete is a comparatively new material and like all new materials and new ways of producing old structural materials it will be subjected to careful investigation from every angle. If it is only just as good as job-made concrete and its cost is no greater, its adoption will be slow, on the other hand if it is found to be inferior its demise will be as rapid and sudden as that of the usual jazz song. The ready-mixed concrete plant must therefore be designed and operated so as to insure the production of concrete at a cost no greater than job placed concrete, of better quality and at a profit to the producer.

*Vice-president Thompson-Lichtner Co., Inc., Boston.

Many of the details of plant design and operation which are of importance from the standpoint of economy and the production of good concrete in place have already been discussed at previous meetings of the American Concrete Institute and in articles appearing in the technical press. The author desires, however, to stress a few items which his experience has shown to be of special importance.

(1) The controlling interests in a ready-mixed concrete organization should include an engineer who really knows something about concrete. His interest will tend to eliminate the possibility of the adoption of a general production and sales policy which would lead to ruinous competitive methods and the production of poor concrete.

(2) The location of the plant should be determined upon only after due consideration has been given to the probable market and its changes as well as the availability of materials. Any plant located where there is little space for storage of materials and where materials have to be brought in by truck usually has a hard time competing with job-mixed concrete. The plant location, which is almost ideal, is an established material supply yard with rail and water connections.

(3) The design of the equipment for ready-mixed concrete plants at present is in such a state of flux that large changes will probably occur in a few years. Gravity feed from overhead bins combined with weigh batchers is in general use. It is not unlikely that the near future will see the installation of automatic weighing apparatus to reduce the operating labor requirements to a minimum and the variations due to errors in measurements.

At present plants frequently have insufficient overhead and ground-storage to take care of failures in conveying and supply systems. The cement batching equipment requires too much attention to keep it in proper operating condition. The truck loading systems are slow. The truck mixers need standardization and further attention to design so as to insure better mixing and control of the mixing.

(4) Control of quality requires the attention of an experienced concrete engineer and the establishment of a laboratory at the ready-mixed concrete plant. It also requires that the jobs be so

serviced that the concrete will be delivered and placed in the forms in proper condition. This means assisting and educating the contractor both before the contract is signed and during delivery of the ready-mixed concrete, so that there will be no delays, so that the means of placing will not cause deterioration in quality, and so that the concrete will be properly protected and cured.

(5) Plant operation has as its principal problem the efficient utilization of the available equipment to supply the demands for concrete. These demands vary rapidly and a schedule of delivery made the night before may be entirely useless the next morning. The attention of one or more men to this item continuously is necessary. Plant operation naturally also has as one of its main interests the keeping of a determination of costs. Neither of these phases has been given the attention they warrant.

Water Control of a Commercial Central-Mixing Plant

BY H. F. THOMSON*

When aggregates are proportioned by weight, as is now the almost universal practice in central-mixing and central-proportioning plants, the problem of water-control resolves itself into two steps, namely the determination of the moisture in the aggregates, and the addition to the mix of such quantity of water as will make up the total amount desired.

It is unnecessary to describe the methods in general use for determining the moisture, as these were fully covered in the paper by William R. Johnson on "Comparison of Methods of Determining Moisture in Sands" presented at the 1929 convention of the Institute†; this paper recommended drying as giving best results. Suffice it to mention in this connection that as a drying determination requires considerable time, it is sometimes difficult, as during a heavy rain, to keep the adjustment for moisture current with the variations in moisture content. Hence there is a distinct need for a method having reasonable accuracy which would give

*Vice President, General Material Co., St. Louis.

†*Proceedings* American Concrete Institute, Vol. 25, p. 261.

results within, say, five minutes of sampling, and hence could be used to check on materials being used at any time.

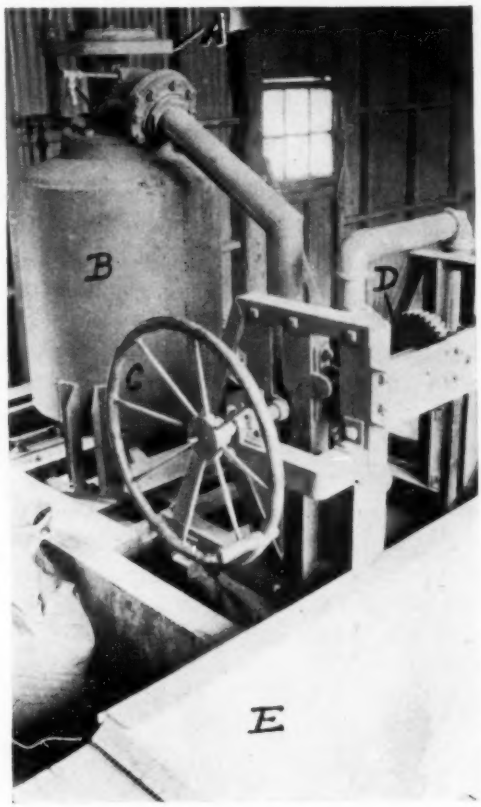
Normally, the water to be added is of greater quantity than the moisture in the aggregates, and hence upon the accuracy of its measurement depends the reliability of the control, so far as concerns the desired water content. This feature of accurate measurement, that is the introduction of the desired quantity of water, no more and no less, requires certain safe-guards. The operation of the valves should be positive, so that the quantity will not depend on such personal equations as the speed of closing or opening the valves. There should be no opportunity for "short circuiting" of water which is not measured, as occurs in the mid-position of the ordinary three-way valve. And there should be no possibility of mal-manipulation by the operator after the inspector or supervisor sets the equipment at the desired quantity, as may happen when the operator must watch a gage glass to cut-off at the proper setting, or when the inlet and outlet valves of the measuring tank are operated manually and independently, thus permitting the operator to add a few gallons beyond the setting if he so wishes.

In addition to accurate measurement, the water regulator should possess two other features; first, the proper timing of the flow of water into the mixer relative to the introduction of the aggregates and the cement, which timing should be constant for successive batches; and second, simplicity of operation, which involves as little physical effort as possible, and also minimizes the items which the operator must watch or manipulate.

It is believed that the water-regulator equipment devised by the writer's organization and operated by us in substantially its present form for the past two seasons, meets the diverse requirements above outlined. This equipment was the outgrowth of a series of successive installations, after a thorough investigation failed to disclose that any mixer manufacturer was offering a water system which would accomplish what we considered should be accomplished by a proper control.

It should be stated that our system of operation has included a batch-hopper between the weigh-hoppers and the mixer, regardless of whether the operating supply of aggregates is stored above

the mixer with gravity fall into the batch-hopper or at the side with other method of conveyance into the batch-hopper. With this arrangement in mind, our analysis indicated that the water equipment should include the following features (1) the measuring



WATER CONTROL EQUIPMENT

A–Dial fixing quantity of water—B–Water tank—C–Hand wheel—D–Gears, actuated by hand wheel, controlling water valves and hopper gate—E–Batch hopper.

tank to be closed (i. e. a pressure tank), the quantity of water for discharge being subject to convenient setting, (2) the inflow of water to the tank and the outflow to the mixer to be controlled by separate valves, and these to be connected mechanically so that, moving in either direction, one valve closes completely

before the other starts to open; (3) the valve operating mechanism to be interconnected with the batch-hopper gate, so that the relative timing of flow of water and flow of materials into the mixer may be adjusted (not by the mixer-operator at will but under the supervision of the superintendent, and not to be changed without dismantling); and (4) an interlock, so that after the water for a batch begins flowing into the mixer the full measured quantity must flow, and no further water can be added without repeating the entire cycle of another full charge.

The equipment as developed includes a closed, vertical tank, the quantity of the discharge being controlled by a syphon whose break can be set by a dial; other methods of controlling the discharge, for instance by displacement, would be equally satisfactory if there is no leakage, the cut-off is positive, and the quantity of discharge accurate in accordance with the setting. The dial is provided with an offset to be set for the moisture, but with different sizes of commercial batches we have found it preferable to subtract the moisture arithmetically from the total water to be in a batch and set the dial for the water to be added. But the unique feature of the installation is the mechanical interconnection of the inlet valve, the outlet valve, and the hopper gate. This is accomplished by a train of gears, some having teeth on only a part of the circumference, which is actuated by a hand-wheel placed so that it can be whirled conveniently by the operator. Starting with the tank full (which may be checked by a gage glass), inlet valve open, and a batch of aggregates and cement in the hopper whirling the handwheel through two full revolutions (it cannot be reversed from mid-position) causes the following sequence of events: (1) inlet valve closes, (2) outlet valve opens, admitting water to mixer, (3) hopper gate opens, admitting materials to mixer, (4) water discharge is so regulated that some water enters after all materials of the batch have entered. After the complete batch is in the mixer, the handwheel is whirled in the opposite direction, which reverses the sequence, the hopper gate closing, the outlet valve closing, and the inlet valve opening, in order.

This type of water measurement equipment has proven very satisfactory during the two years operation, being used by our

company on six two-yard central-mixers during the last season. The tank discharge has been quite accurate, checking repeatedly within ½ pint of the dial setting for quantities of 30 to 75 gallons. We have felt that the interconnection of the valves and the impossibility of the operator adding any water to that of the dial setting is a guarantee of accuracy, as it removes the human element. The positive relative timing of the introduction of water and materials into the mixer, as determined by experience, results in only a minimum collection of solid matter within the drum, which eliminates much of the labor and lost time of cleaning; during the season a mixer used daily and flushed noon and evening with a charge of water, operates approximately two months between cleanings. And withal, the work of the operator is so simplified, both mentally and physically, that he can do more with greater reliability than if he must watch water gages and operate valves.

In short, we feel that the extra investment in this type of mechanical equipment is justified by the assurance of accurate water measurement, which means more uniform concrete and hence better service to the trade.

Notes from Experience in Mixing Plant Operation

BY N. D. CROWLEY*

If I make frequent reference in this paper to our own plant, please attribute it to the fact that that is the only one with which I am thoroughly familiar, and am simply bringing up certain problems and the manner in which we solve them, with no recommentation as to the worth of the solutions.

STORAGE OF AGGREGATES

In designing a central mixing plant for commercial purposes, there are two prime factors which must be kept forcefully in mind at all times; one of them the storage of different aggregates in bulk; the other, storage of these same aggregates in the bins. By the former I mean ground storage principally, and by the latter, a bin of sufficient size to allow several compartments for different sizes of coarse aggregates.

*President, Albany Trucking Co., Albany, N. Y.

It has been our experience many times in the last summer to have calls for concrete to be made of five different coarse aggregates in one day, and then for several succeeding days every customer seemed to want the same size. Obviously, if one is to give the customer what he wants, then it is not only necessary to have several compartments in the bins, but also that each compartment have sufficient capacity in itself to take care of the rush days in any particular size.

With this in mind, I believe therefore, that the material bin should contain not less than six compartments, and each compartment not less than forty cubic yards. In a great many cases this may have to be reduced because of the difficulty of loading such bins with a crane, but if possible, this should be figured as a minimum.

CEMENT

Wherever it is at all possible to install a conveying system, bulk cement should be used. Not only is considerable labor saved, but cement in bulk is ten cents per barrel cheaper than the net price in cloth bags, and twenty-five cents per barrel less than in paper bags. In addition, when cement is weighed into the batch, which is the only accurate method, and one which is rapidly becoming obligatory, every pound which goes back to the mill in the sacks is the operator's loss directly.

The cement can be pumped or conveyed into a bin of about the same elevation as the material bin, and then conveyed by one or more screw conveyors to the cement weighing hopper which should be in close proximity to the material weighing hopper.

MATERIAL CONTROLS

On the mixing platform, the levers for the discharge of the fine and coarse aggregates into the weighing hopper, and the cement into its weighing hopper, as well as the controls of the water tank and batchmeter, should be banked in and around the operator. This can be very easily arranged, and is extremely important when the plant is in full operation. Combination bar and dial overrun scales for the weighing of the fine and coarse aggregates, and direct action dial for the cement hopper, seem to be at the present

time, the most popular method of accurately measuring the materials.

MIXER

I believe that the mixer should be of three yard capacity so that the entire batch of whatever size up to and including three yards, can be mixed at one time. The original cost of a three yard machine over one of smaller size is not great, and will be more than offset in a short time by the saving in truck time at the loading plant. With this size machine we have found that three yards of concrete will be thoroughly mixed in two minutes after all of the aggregates are in the mixer. This is based on a batch-meter of standard make.

TRUCKS

We have become convinced that, in our section at least, the trucks should be of either one-yard or three-yard capacity, for the following reasons:

A three-yard load can be hauled at a less cost per cubic yard mile than one of smaller size, but many smaller loads are required, and it certainly is not good business to send a six ton truck with a one or two ton load, if it is possible to avoid it. Since the greatest charge against hauling costs is the depreciation of hauling equipment, and since such depreciation is based on the original cost, one or more light, cheap, fast trucks of one yard capacity are a valuable adjunct to any plant. However, the moment the operator goes over this two-ton load, he must get into heavy equipment anyhow, and since the difference in original cost, between trucks capable of hauling three and four-ton loads, and those hauling six-ton loads, is slight, it seems to me he might better equip with the larger trucks for all loads over one yard. On the other hand, I do not think it practicable in most cases, with a commercial plant, to haul over three yards to the load because of the difficulty the customer may have in handling a larger amount on the job.

TRUCK BODIES

In connection with hauling centrally mixed concrete, I am frank to say that I feel there is not an entirely satisfactory body for all uses on the market at present, but of course with the growth

of this industry, there is sure to be one or more developed shortly, which will meet at least ninety per cent of the criticisms of engineers, consumers, and operators. Almost any body that is equipped with some means of breaking the concrete loose before dumping will handle concrete up to a three or four-inch slump satisfactorily, whether of the revolving, agitator or non-agitator type. We use a non-agitator type, and have hauled as far as eighteen miles from our plant with no particular trouble from segregation, but when we attempt to haul long distances with a sloppy mix, we do encounter difficulty with segregation.

It therefore behooves each operator to determine for himself the nature of most of the concrete placed in his section, and govern himself accordingly in the type of body selected. For example, if the major portion of his work is to be roads and pavements, or other classes of work where particular attention is paid to the water-cement ratio, then he will not have much difficulty with segregation, regardless of the type of body. If, however, the major portion of his concrete will go to jobs requiring thin mixes as in small walls with fine reinforcement, then he should avail himself of any means he can to obtain or develop a body which will handle this kind of concrete.

In this connection, I believe it to be of major importance that each operator strive continually to educate all of his customers against sloppy concrete. Many of them erroneously believe they will save labor by using a concrete which will flow readily, and thus require very little spading or tamping. Of course we all know that such concrete is far from being satisfactory, and in most cases the labor thus saved is actually used later in patching.

DESIGN OF MIXES

If it is at all possible to obtain the services of a concrete engineer and chemist to look after the quality of the concrete, and design the mixes, I think it is the first thing each owner should do before putting his plant in operation.

In this way, scientific mixes will be established. Tests of the concrete at the mixer and on the job can be made systematically. Cement can be tested. Moisture contents can be taken frequently, and corrected for immediately, as well as innumerable other duties, all of which will improve the quality of the concrete,

besides taking care of the educational work necessary among engineers and architects. As an illustration, at our plant we now have a total of thirty different mixes. You can readily see that a layman would be entirely at a loss in figuring these and be assured at the same time, that he was not only manufacturing good concrete, but that his yardage was exactly correct. I feel so strongly on this point that I am confident that when the time comes that all concrete will be sold on a strength basis, rather than a particular mix, the concrete engineer can easily save several times his retainer fee in cement alone.

PEAK LOADS

I wish to bring out one point which is more of a problem in operation than any other—peak loads.

Obviously no operator can afford to own enough hauling equipment to take care of all of the business that may come to him at any one time, and we have endeavored to solve this particular problem in the following ways:

First: Continually impress upon customers the necessity of calling at least one day in advance of placing.

Second: Prepare a schedule each evening so that the proper number of trucks will be allotted to each job the following day, and if possible, allow for one or two trucks to be free for incidental orders.

Third: Allow plenty of time on this schedule for each truck, to take care of delays in transit or on the job.

Fourth: Teaching drivers continually to impress on customers in a courteous way, that they are on schedule, and must not be held up.

Fifth: If a customer calls, and all of the available trucks are scheduled to be busy until a certain hour, he is so informed, and we then make every endeavor possible to deliver the concrete at the exact time promised.

From all appearances, the time is not far distant when practically all concrete will be premixed. During this evolution, many of the problems, such as the last one mentioned, that of peak loads, will be permanently solved. I can conceive of a chain of plants interchanging hauling equipment. To illustrate, if each of five plants needed ten trucks to take care of its cus-

tomers satisfactorily, probably a total of thirty to forty trucks would be at all times sufficient to service all five, provided the trucks could be moved as needed from one plant to another. This, of course, immediately cuts the initial investment enormously. It also removes the bugaboo which faces each owner, of being unable to give proper service to each job. when there are several running at the same time.

RECENT DEVELOPMENTS AND TRENDS IN THE COMMERCIAL CONCRETE BUSINESS

BY FRED C. WILCOX*

IN STUDYING recent developments in the design and operation of central concrete plants, we are confronted with the truth of an old saying that, "A little knowledge is a dangerous thing." The facts are that within the last two or three years the subject of central plants has become submerged in and largely subordinated to a new phase of the concrete industry known as commercial or ready-mixed concrete. Developments in this method of producing concrete have been moving so rapidly that we have had to recast our ideas of central plant methods and equipment almost as soon as they were formed.

I will not attempt more than to outline briefly recent trends in central plant methods in a cross-section of the ready mixed concrete business comprising the North Atlantic Seaboard States, where the activity has been most pronounced and has come under my personal observation during the last three years.

Not quite three years ago, or in March, 1927, a bulletin issued by the Portland Cement Association on "Central Mixing Plants for the Manufacture of Premixed Concrete" listed only 29 plants in various parts of the country engaged in this infant industry. This list included only one plant east of Pittsburgh. It gave no estimate of the amount of capital invested in these plants, but assuming $50,000 as the probable average cost of plant equipment and transporting units used at that time, the total investment was only about a million and a half.

*New York City.

Two and a half years later, or in September, 1929, the Portland Cement Association had received reports from its district offices indicating at least 125 commercial concrete plants in various cities and towns throughout the country. My own first hand survey at that time showed 38 plants in 23 cities and towns east of Pittsburgh. These were confined to six New England and North Atlantic States and the District of Columbia. The average cost of equipment for making and transporting concrete in the modern commercial plant is now probably in excess of $80,000. This is exclusive of the value of plant sites and buildings; so the total capital invested in this rapidly growing business has increased about ten times in the last two or three years, and is now well in excess of ten million dollars.

It is evident that the increasing use of ready-mixed concrete will be a dominant factor in the development of central plant methods, therefore it is of interest to estimate the present rate of production of commercial concrete. We have no exact production figures on the whole industry, but we can get a sufficiently accurate picture by taking the known output of nine average plants in large and small towns in four Atlantic States over an average period of six months operation in 1928 and 1929. The largest of these plants produced concrete at the rate of 115,200 cu. yds. a year, the smallest at 3600 cu. yds. a year, and the average rate of the 9 plants was slightly over 45,000 cu. yds. a year. The average selling price was around $9.00 a cu. yd. Using these figures as a basis of calculation, commercial concrete was being turned out in the United States at the end of 1929 at the annual rate of over 5,000,000 cu. yds., which in value is close to $45,000,000.

It is true this is not much over 5% of the total amount of concrete used in the United States in 1929, but the volume is so great and the proportion is increasing so rapidly that it justifies the serious study which the Institute has undertaken of central plant methods of manufacture and control.

Within the last three years the making and marketing of central plant concrete appears to have fully established its soundness from an economic standpoint. At the same time it has been getting on a sounder footing from an engineering angle, due large-

ly to a growing recognition of the principle that in order to establish the business on a thoroughly sound and permanent basis, ready mixed concrete must show its ability to improve quality consistently along with its possibility of lowering production costs.

The strongest evidence of this is to be found in a number of changing trends in the methods of producing and transporting commercial concrete. These methods fall into two general classes known as the wet system and the dry system. In the wet plant system, the concrete is premixed in a stationary central plant mixer and hauled to the job in various types of units. The dry plant system includes a central proportioning plant and truck-mounted mixers for mixing in transit or after they have reached the job. Both methods are central plant systems, the essential difference being in the units used for transporting the concrete from the central plant to the point of deposit.

Up to two years ago, a majority of commercial concrete plants were wet plants. Based on experience prior to that time, it had become a pretty general assumption that the best control of concrete could be secured in the central mixing plant, or wet type plant. This assumption, however, appeared to neglect the factor of control while transporting the concrete from the central plant to the point of deposit, and the tendency to transport it in various types of units such as plain bodies, bath tub bodies and non-agitating bodies, until finally the agitator body designed to prevent segregation in transit was developed and came into more general use.

Within the last year, in the section covered by my study, there has been an unmistakable trend toward the system of central proportioning and mixing in transit, which may be termed the truck mixer system, as contrasted with the central mixing plant method of premixing the concrete and hauling it in agitator bodies. This trend is evidenced by the fact that in a total of 26 plants installed and put in operation in this section in 1929, fourteen were dry plants and only twelve wet plants. Prior to that time, practically all commercial concrete plants installed in this territory had been wet plants. In the metropolitan sections of Boston and New York, nine out of thirteen new commercial plants put in operation in a period of twelve months ending in

September, 1929, were dry plants. Without getting into a technical discussion of the relative merits of the two systems, it may be well to analyze the apparent reasons for this changing trend in commercial plant operation, and its soundness from the viewpoint of design and control of central plant concrete.

From an operating standpoint, which is no doubt an important factor in this trend, there appear to be a number of advantages in the system of central proportioning and mixing in transit. Passing over these briefly, they include, lower initial plant cost by eliminating the central plant mixer and saving about ten feet in headroom; lower plant operating cost and a saving of truck time, in which the elimination of mixing time at the central plant is an important factor because with truck mixers the mixing time can be absorbed in the hauling operation; and greater flexibility in extending plant operations. Eliminating from this analysis the admittedly cheaper hauling units such as plain bodies, bathtub bodies and non-agitator bodies, on the ground that they can have no permanent place in building up the ready mixed concrete industry on a sound basis, there is very little if any difference between the cost or the weight of properly designed agitators and well designed truck mixers. Furthermore, a good truck mixer is essentially a good agitator, and can be used in either the wet or dry plant system to equal advantage.

Coming to the engineering angle, which includes not only the mixing but the transporting and placing of concrete, it seems to me we find the most important considerations for the trend toward the mixing in transit system. It seems to embody all of the best processes and practices that have been developed in the making of concrete. This applies to both scientific control and economy of manufacture. It is a central plant system, and therefore includes all the advantages and economies of centralized control which are a part of the central mixing plant method of production.

It permits centralized control and inspection of aggregates. It includes accurate control of water, either at the central batching plant (in the same manner as in a central mixing plant), or in transit to the job.

In truck mixers the actual mixing process can be completed in

mixing units of standard and proven design, that is, revolving drum mixers, with an effective mixing time longer on the average than that specified in a central plant mixer. Moreover, it can be lept under equally good control with a simple batchmeter device for recording the number of drum revolutions while the truck mixer is in transit to the job or after it has reached the job.

In short, the truck mixer system (as compared to the central mixing plant system which involves the hauling of premixed concrete to the job in agitator or other type bodies) appears to afford the best possible control of the time element in mixing, transporting and placing concrete, because admission of water and the starting of the actual mixing process when desired can be regulated to suit the length of haul and the possibility of delays in receiving and placing the concrete, so as to preserve its original strength and workability and avoid the possible effects of premature initial set.

THE USE OF CENTRAL MIXING PLANTS BY THE PORT OF NEW YORK AUTHORITY

BY A. W. MUNSELL*

THE QUALITY of the concrete required under present day specifications can be obtained only by methods of control that will deliver specified mixtures and uniform batches, both of aggregates and water. From the beginning of the work on the two bridges across the Arthur Kill between Staten Island and New Jersey to their completion in 1928 the central plant principle was followed by the Bridge Department of The Port of New York Authority, and has been included in all specifications covering the Kill Van Kull Bridge between Bayonne, N. J., and Port Richmond, S. I., and the world's largest suspension bridge, the Hudson River Bridge, between 178th Street, New York City and Fort Lee, N. J., both of which are now under construction.

The methods used have included volume, inundator, and weighing batchers, and the specifications for the last two years have required that all aggregates be measured by weight exclusively.

In all there have been six central mixing plants and 11 batching plants. The batching plants were all in building supply dealers'

*Engineer of Masonry Inspection, Port of New York Authority, New York City.

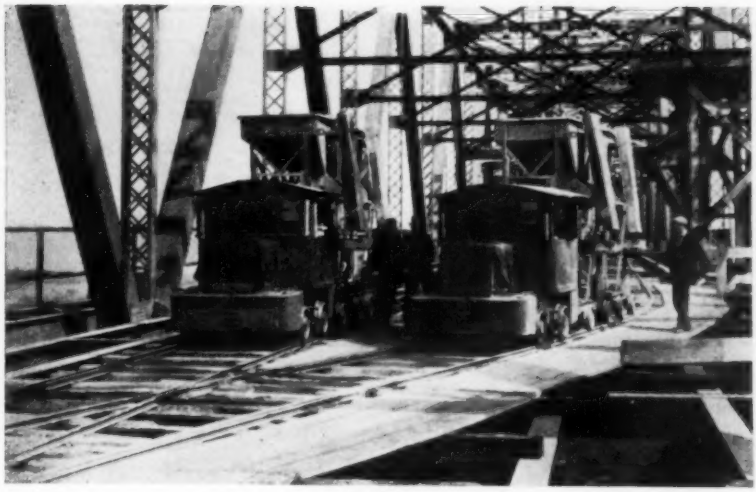


FIG. 1—OUTERBRIDGE CROSSING—TYPICAL HOPPER CARS WITH SIDE DISCHARGE AND FOLDING CHUTES

yards but have met our specifications for measurement by weight. In all cases the weights were set by inspectors permanently assigned to the yard and all batches were measured under their supervision. The batches were hauled in compartment trucks to paving mixers where other inspectors fixed the amount of mixing water for the particular job.

All the aggregates and cement were inspected and tested before shipment. The aggregates were all shipped by water and the inspector at the pit or quarry gave a ticket to the barge captain for delivery to the inspector, which included all the necessary information for the concrete inspector to make such changes in his weights as were indicated.

Five of the central mixing plants are described only briefly because they presented no novel features of a mechanical aspect nor overcame any topographical difficulties.

OUTERBRIDGE CROSSING—PERTH AMBOY APPROACH PIERS

This plant was set up at the water edge approximately 500 ft. south of the bridge right-of-way on a dock built for this purpose.

The aggregates and sacked cement were delivered on barges and lighters and the aggregates were lifted by a clam shell bucket operated from a stiff leg derrick to hoppers over the mixing plant. The equipment consisted of an inundator for fine aggregates and volume batcher for large aggregates and the aggregates dropped into a hopper from which two 21-S mixers were fed alternately. Cement was carried up to the mixing platform on a belt conveyor on which batches of loose cement were dropped from a hopper at the lower end into which the cement had been emptied from the sacks, and the cement from the belt fed into a screw conveyor on the batching platform from which it dropped to the hopper holding the aggregates. The concrete was carried in side dump buckets on an industrial railroad to the pier locations where they were picked up by a crane and on the higher columns were discharged into a skip at the bottom of a mast and elevated to a hopper which discharged into a chute for final placing. The water was controlled from the auxiliary tank accompanying the inundator.

OUTERBRIDGE CROSSING—BRIDGE DECK

The same plant was used for the deck concrete except that weighing batchers were substituted for the inundator and volume box and a homemade water tank with an adjustable overflow pipe was used for control of mixing water. The concrete was discharged into side dump buckets hauled approximately 700 ft. to the bottom of an elevator where the buckets emptied into a skip which was raised 140 ft. to a hopper with a capacity of three yards, elevated approximately 12 ft. above the bridge deck from which the concrete was drawn off into industrial cars with a hopper elevated about 8 ft. above the rails and equipped with a side opening gate which discharged into a folding chute attached to the cars. The cars were hauled on a standard gauge track with gasoline dinkeys to the place of deposit where sufficient fall was given by the height of the cars to chute the concrete into place. The haul was approximately 5,000 ft. from both sides of the elevator.

GOETHALS BRIDGE—BRIDGE DECK

This plant was at Howland Hook, S. I., and was similar in all respects to the above described plant except two 28-S mixers and

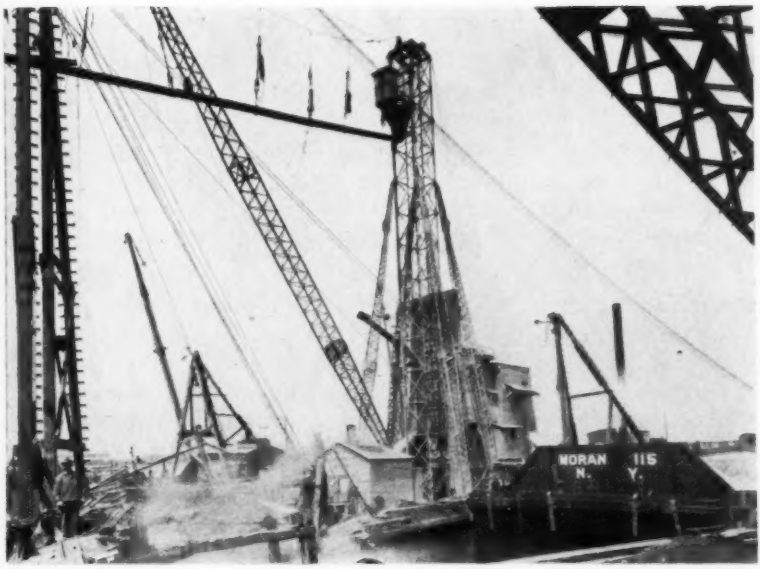


FIG. 2—BAYONNE-PORT RICHMOND BRIDGE—FLOATING MIXING PLANT EQUIPPED WITH WEIGHING BATCHER FOR BULK CEMENT

closed water measuring tanks were used. The mixers discharged directly into an elevator skip which was raised above the deck to a hopper for emptying into the same type of cars described. The haul for this bridge was approximately 4,000 ft. on each side of the elevator.

KILL VAN KULL BRIDGE—MAIN PIER

This was a floating plant, which was used first, for the main pier at Port Richmond and then moved across Kill Van Kull to the Bayonne pier site. This plant was equipped with an inundator for fine aggregate, a volume batcher for large aggregate and a weighing batcher for the bulk cement which was used on this contract only. In operation, a barge of aggregates loaded one-third fine and two-thirds coarse was placed on one side of the plant with a lighter of bulk cement on the other. A stiff leg derrick mounted on the mixing plant equipped with a clam shell bucket kept the hoppers of the aggregate and cement bins filled. A tarpaulin cover was kept over the cement bin all the time except

when being filled. For the Port Richmond pier cement was shipped in bulk in ordinary box cars to Jersey City, N. J. and transferred by gravity in chutes to the lighter. On the Bayonne pier the cement was shipped in sacks to Jersey City, N. J. and the sacks emptied into the lighter. In operation, the aggregates with the weighed amount of cement were discharged into a two-yard mixer which emptied into an elevator skip mounted on the concrete plant barge. The skip was raised approximately 60 ft. and discharged into a hopper which fed into a system of chutes, suspended on a cable, that extended from the top of the elevator framing to an anchorage on shore. These chutes distributed the concrete to the place of final deposit.

HUDSON RIVER BRIDGE—NEW JERSEY TOWER BASES

This plant was erected at the base of the Palisades approximately 150 ft. from the delivery point of aggregates and cement which were received in barges and lighters. The aggregates were carried on a conveyor belt fed from a hopper to a bucket elevator and alternately carried fine and coarse aggregate as required. The bucket elevator, approximately 50 ft. high, was equipped with a flapper gate at the upper end which alternately discharged into the fine and coarse bins over the weighing batchers, which served one two-yard mixer equipped with an open top water measuring tank calibrated and adjustable to measure the amount of water to one quart. The cement in sacks was unloaded on conveyor belts to a cement storage shed close to the plant from whence it was conveyed on a belt to the mixer platform as needed. The concrete was discharged into two-yard capacity bottom dumping buckets set on industrial cars which were hauled approximately 100 ft. to be within reach of the boom of a stiff leg derrick which picked up the buckets and lowered the concrete into its final position.

HUDSON RIVER BRIDGE—NEW YORK ANCHORAGE

This plant presented some unique problems aside from the large mass of concrete involved (108,000 cu. yds.) and is described more in detail than the others.

The storage piles of aggregates and the shed for cement storage were at the waters edge approximately 800 ft. from and 120 ft.

lower than the site of the mixing plant, and across a railroad cut approximately 250 ft. wide. The roughness of the topography required the building of a wooden trestle, in some places 60 ft. high, and a suspension bridge supported on 2-1-in. wire cables across the railroad cut to bring the aggregates and cement to the mixing plant.

Aggregates and cement were received in barges and lighters at the dock where the aggregates were unloaded by clam shell buckets operated by a stiff leg derrick which dumped on a tunnel. In the tunnel a 26-in. belt operating at a speed of 375 ft. per minute received either coarse or fine aggregates from segmental gates, opened in a fixed position for the flow of the proper amount of material without spilling. This conveyor emptied onto another belt of the same width at right angles to the first, rising at an angle of approximately 16° which discharged onto a third belt of the same width just short of the suspended span over the railroad cut, which in turn carried the material to a 300-ton steel bin over the batchers. These two belts operated at a speed of 400 ft. per minute and had a capacity of 300 tons per hour. The belts operated on troughing idlers, were equipped with screw take-ups and were belt driven from electric motors.

The cement in sacks was unloaded by ships tackle from the lighter to the mixing plant on one continuous belt, 20 in. wide, operating at a speed of 90 ft. per minute and had a capacity of 50 tons per hour. Most of the cement was conveyed to the mixing plant, but surplus storage was provided in a shed at the dock.

The mixing plant equipped with two 28-S mixers operated by electric motors were served with one 6,000 lb. weighing batcher dumping alternately in hoppers behind each mixer.

Cement was introduced in the hoppers behind the mixers in a 12-in. diameter pipe, with a flared upper end and a flapper valve at the bottom, which was filled with the proper number of sacks per batch, emptied into the pipe from the cement storage dock about 12 ft. above the mixing platform.

Closed water measuring tanks, equipped with two air release valves and calibrated to half gallons supplied the mixing water for each mixer.

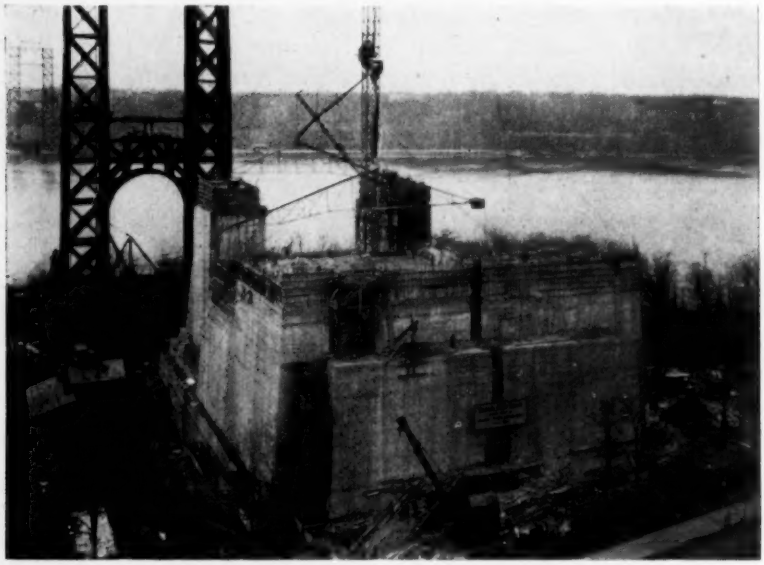


FIG. 3—HUDSON RIVER BRIDGE—MIXING PLANT (IN LEFT FOREGROUND) FOR THE FIRST SECTION OF THE NEW YORK ANCHORAGE

Each mixer was equipped with a timing device of the escapement type which automatically locked the discharge chute and fixed the duration of the mixing time to 1½ minutes.

The mixers discharged into a hopper of 3 cu. yds. capacity which fed onto a 22-in. belt approximately 150 ft. long, carried through a tunnel in the south wing of the anchorage, operating at a speed of 550 ft. per minute, with a capacity of 150 tons per hr. This belt discharged into a two-yard capacity hopper at the foot of a 260-ft.-high tower placed in the center of the anchorage and equipped with a 36 cu. ft. reversible bucket and two 75-ft. booms and 75 ft. counterweights placed on opposite sides of the tower on sliding frames. This equipment gave complete coverage of the anchorage area.

The hopper at the mixer and the hopper which discharged into the hoisting bucket were made of ample size for the purpose of giving continuous operation for mixing and placing plants even though one or the other might be stopped for several minutes.

The tower hoist was operated by a 100 h. p. electric motor giving a line speed of 380 ft. per minute which could be increased to 425 ft. per minute by lagging the drum.

All motors were built for continuous duty and started under full load. This applied to those on the belts as well as on the hoist and mixers.

The plant mixed and placed as high as 1,600 cu. yds. in 20 hours in two shifts.

As a large portion of this work was in the Fall and Winter a 50 h. p. steam boiler was used for heating the water which supplied the measuring tanks. Also the hoppers of the aggregate bins were lined with steam coils to thaw and heat the aggregates. This equipment was adequate to supply concrete which in no case was below 50° F.

Field laboratory. For control of the quality of the concrete a field laboratory was set up in a space under the mixing plant, where specimens were made for tests in compression, and the examination of the aggregates for moisture content in order that changes in the amount of mixing water might be made quickly.

The concrete was designed according to the water-ratio law for a strength in compression of 2460 lbs. at 28 days with 7 gals. of water and 5 sacks of cement per cu. yd. of concrete in place.

Test results from 283 8 x 16-in. cylinder test pieces broken at 28 days show an average strength of 2390 lbs. per sq. in. in compression of which 79 per cent of the specimens were within 20 per cent of the average. On completion of the work it was found that 108,022 cu. yds. of concrete had been placed, using 525,474 sacks of cement at the rate of 4.86 sacks per cu. yd. of concrete.

Preliminary tests—object. In the operation of the plants the proportions to be used and the amount of water are fixed by the results of preliminary tests of the aggregates and cement that are to be used on the particular contract. The object of these preliminary tests were: (1) To obtain data as to the change of strength when the ratio of the water to the cement was varied. (2) To determine how the grading of the aggregates affected the workability and what grading of the aggregates limited the work-

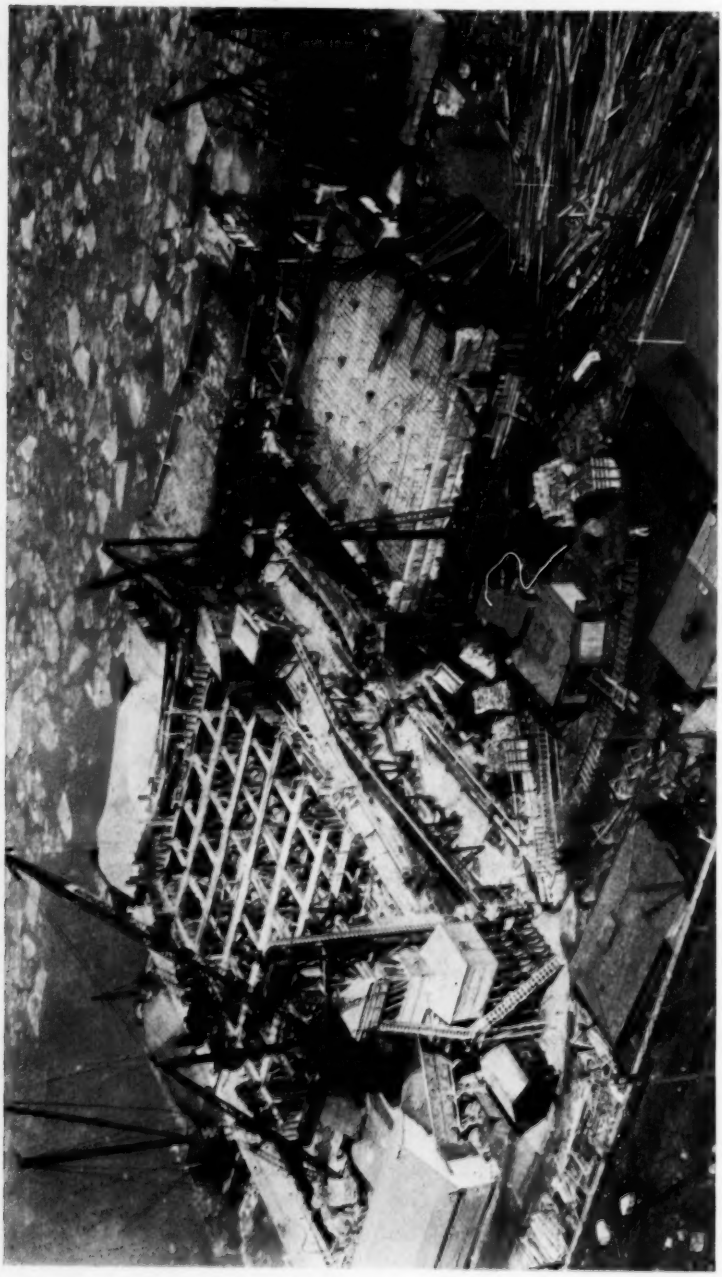


FIG. 4—HUDSON RIVER BRIDGE—CENTRAL MIXING PLANT AND LAYOUT, NEW JERSEY TOWER BASES

ability of the resulting concrete. (3) To determine the most economical mix that would give the desired consistency with the safe minimum strength required by the specifications.

Materials. The cement was required to meet all the requirements of the A. S. T. M. specifications and the aggregates met our requirements as to size and grading, and the A. S. T. M. specifications as to physical properties. The coarse aggregates are a combination of two commercial sizes, 2½ in. to 1¼ in. and 1¼ in. to ⅜ in. The fine aggregates are a combination of commercial sand, and grits, which is a pea size gravel finer than a ⅜-in. screen and held on a No. 8 sieve.

The fine and coarse aggregates were used in a room dry condition, the surface moisture had evaporated but the absorbed moisture was still retained. This method permitted the use of 0 per cent moisture content and the disregard of the water that would be absorbed by the aggregates before the concrete had set. If the aggregates had been dried to a constant weight, an extra quantity of water would have to be added to the mixing water to give a proper water-cement ratio after part of the mixing water had been absorbed. The use of absolutely dry aggregates would affect the consistency also as there would be more water present at the time of mixing than should be for any given water-cement ratio.

Methods. The fine and coarse aggregate was separated in their several sizes and re-combined to meet a fineness modulus of 7.5 for the coarse and 5.0 for the fine. The fine and coarse aggregates were mixed in varying proportions of each so that the F. M. of the mixed aggregates were 5.2, 5.4, 5.6, 5.8, 6.0 and 6.2. The weights per cu. ft. of these different mixed aggregates were determined by the A. S. T. M. standard method which were used in computing the volume of mixed aggregates in each batch.

Water ratios of .7, .8, .9, 1.0 and 1.1 were used in making the test pieces, the concrete for which was made in the following manner: Fine and coarse aggregates were mixed to give the desired F. M. of mixed aggregate and in an excess quantity of the amount required for one cylinder. This mixture was added to a cement paste of the water-cement ratio for the particular specimen until the desired consistency was reached as measured

by the slump test. The concrete was molded into a 6 x 12-in. cylinder in accordance with A. S. T. M. standard methods and the excess concrete was measured in another cylinder, and the volume of this concrete was used in computing the actual yield. The remaining mixed aggregate was then weighed. The difference between the original weight and the weight of the mixed aggregate remaining gave the amount of mixed aggregate in the batch.

Test pieces were made for each different F. M. and W/C on five different days until the groups had been repeated five times. Two of each group were broken at 7 days and three at 28 days.

Calculations. The following data were recorded when the test pieces were made: The quantities of cement, water and mixed aggregates used; the unit weights of the fine, coarse and mixed aggregates; and the F. M. of this fine, coarse and mixed aggregates. From this information the real mix (one part of cement to — parts of mixed aggregates by volume in dry and rodded condition), the nominal mix (one part of cement to — parts of fine aggregates to — parts of coarse aggregates by volume in a dry and rodded condition), and the number of sacks of cement required for one cu. yd. of concrete, were calculated.

The strength of the test pieces having the same water-cement ratio were averaged to obtain the strength for each water-cement ratio, and these average strengths were used in computing the constants for the exponential equation $S = \frac{A}{B^x}$. From this equation, using the computed constants, curves were drawn for use in the field.

The water-cement ratio law has been in effect on all contracts since the beginning of work, and in order that it might be understood lectures were given to groups of engineers' and contractors' men at each new contract, and in the case of individual inspectors who take the samples and make the specimens, instructions were given at the laboratory where the theory of the water-cement relation and the proper sampling and making of test pieces were explained and demonstrated by qualified instructors.

The excellence and uniformity of the concrete resulting from these control methods are partly shown in the summary of the results from 7 contracts in which the data given by the preliminary tests is compared with the results of the tests obtained from the same materials taken in the field.

It will be noted that all of the ingredients of the concrete are variable except the water. All of the materials were weighed either at central mixing plants or at central batching plants, except the laboratory building where the proportions were fixed by struck off volumes compensated for bulking in both aggregates.

In the strength results a maximum difference of 8 per cent is shown between the average strength of the preliminary tests and the average actual strength from the tests in the field. These results are from all test pieces, none were eliminated for any reason, although some individual tests could have been discarded for poor sampling or poor workmanship in the test pieces. All results were taken as being representative of the whole mass. The difference between the average preliminary test strengths and the average field strengths is ninety lbs. or approximately 3.0 per cent. The maximum difference in the preliminary tests is 370 lbs. or 13.4 per cent and the field tests 290 lbs. or 10 per cent.

The economy in the use of cement to secure a safe minimum strength without waste is shown in the comparison of sacks of cement used per cu. yd. of concrete where the actual cement used over the expected was kept within 5 per cent of the quantity predicted or 5 lbs. in the cu. yd. of concrete. While some of these contracts used slightly less cement than was recommended there was no aim to save cement over the quantity recommended for each contract. The large runs of concrete per day helped to save cement as there was less loss of concrete caused by changing from one location to another.

Our specifications require that this class of concrete shall have a minimum strength of 2500 lbs. per sq. in. at 28 days using 6½ gallons, or less, per sack of cement. The results of preliminary tests showed that strength from 10 to 20 per cent higher than required could be obtained using 6½ gallons of water, and the water was not reduced as this was considered a safe working margin and gave added workability.

The maximum difference in proportions from those recommended was .11 of a part in the fine aggregate and .24 of a part in the coarse aggregate in the first two contracts in the tabulation only, which was largely due to a change in the source of the fine aggregate which caused a reduction in the proportions to secure proper workability. The other proportions used are so close to

SUMMARY OF RESULTS OF TESTS ON FIELD CONCRETE. 6.5 GALLONS OF WATER USED ON ALL CONTRACTS. AGE AT TIME OF TEST—28 DAYS

	Outer-bridge Crossing Deck Slab	Goethals Bridge Deck Slab	Hudson River Bridge N. J. Anchorage	Kill Van Kull Bridge				Average
				Main Piers	Bayonne Approach	Pt. Rich Approach	Laboratory Building	
Expected Strength Prelim. Tests	2900	2900	2680	2730	3050	2850	2760	2840
Actual Strength from Field	2910	2980	2850	2910	3070	3100	2810	2950
Variation from Expected Strength, %	+0.3	+2.8	+6.3	+6.2	+0.7	+8.0	+1.8	
Variation from Avg. of Act. Str., %	1.4	1.0	3.4	1.4	4.1	5.1	4.7	3.0
No. of Specimens Broken	47	42	31	112	93	86	22	
Sacks of Cem./Cu. Yd. Prelim. Tests	6.35	6.35	6.20	5.46	5.90	5.96	5.85	
Sacks of Cem./Cu. Yd. Actual	6.30	6.40	6.30	5.30	6.01	5.63	....	
Variation from Exp. Cem./Cu. Yd. %	−0.8	+0.8	+1.6	−2.9	+1.9	−5.5	....	
Slump Prelim. Tests	3.00	3.00	4.00	4.00	4.00	3.00	3.00	
Actual Avg. Slump	4.56	3.35	3.97	3.22	2.38	2.46	3.52	
Recommended Prop. Prelim. Tests	1:1.71:3.35	1:1.71:3.35	1:2.00:2.75	1:1.79:3.44	1:2.15:3.09	1:2.17:2.93	1:2.06:3.04	
Actual Prop. Avg.	1:1.82:3.11	1:1.67:3.11	1:2.02:2.70	1:1.80:3.44	1:2.20:3.04	1:2.13:3.03	1:2.06:3.04	
Recommended Real Mix	1:4.20	1:4.20	1:3.87	1:4.46	1:4.24	1:4.13	1:4.38	
Act. Real Mix Avg.	1:4.00	1:3.88	1:3.82	1:4.46	1:4.24	1:4.18	1:4.38	
Brand of Cement	A	B	C	B & D	C	A	C	
Source of Fine Aggregate	No. 1	No. 1	No. 2	No. 2	No. 2	No. 3	No. 4	
Source of Coarse Aggregate	No. 5 Cr. Stone	No. 5 Cr. Stone	No. 6 Cr. Stone	No. 7 Gravel	No. 5 Cr. Stone	No. 5 Cr. Stone	No. 8 Gravel	
Cu. Yds. of Conc. placed	11,313	9,260	16,303	33,067	14,724	13,380	....	
Sacks of Cem. used	71,240	59,224	102,639	175,100	88,424	75,420		

those recommended that they are practically the same, which is due to the uniformity of the aggregates, the grading of which was kept constant by the use of a two size fine aggregate and a two size coarse aggregate which permitted different combinations of these sizes as required to give the same results.

These same remarks apply to the differences in the recommended real mix compared with the actual real mix as used in the field.

CONCLUSION

The use of central mixing plants and central batching plants has been found to give uniform concrete both in regard to consistency and strength, and is economical to both the owner and the contractor in that it insures uniform strength for the owner and uniform consistency and workability for the contractor. There is no added expense in the field required by these plants as an inspector would be required in any case in the placing of the concrete, and only a small portion of his time is taken for adjustment of the water.

Readers are referred to the JOURNAL *for September 1930 (Vol. 27, No. 1) for further discussion which may develop. Such discussion should reach the Secretary by August 1, 1930.*

Discussion of Report of Committee 502

Proposed "Construction Specification for Concrete Work on Ordinary Buildings*"

BY H. M. BROWN† (BY LETTER)

The construction specification proposed by Committee 502 in the November Journal *was tentatively adopted by the 26th annual convention, subject to amendments here recorded, as: Tentative Construction Specification for Concrete Work on Ordinary Buildings (502-30T). Written discussion of the specification as first proposed is published here, followed by Mr. Lord's discussion in presenting the report to the convention. If the tentative specification stands without further amendment, it will be in order at the 1931 convention to move its submission to letter ballot as an Institute Standard. There will be further opportunity for discussion in the* Journal *for September 1930 (Vol. 27 No. 1). Such discussion should reach the Secretary not later than August 1, 1930.*—Editor.

It is disheartening to see that a contractor is still required to furnish labor and material regardless of the fact that they are not definitely shown either on plans or in specifications. Certain items, as for example lintels and copings, may or may not be of concrete. If the plans and specifications are so indefinite as not to show the type of construction desired, shall they be furnished by the contractor? If the contractor is ordered to furnish any labor or material not definitely shown on the plans or listed in the specifications, shall the contractor design such members as are to be placed? In my opinion this specification would be improved

*Presented by Committee 502, Mixing and Placing Concrete in Buildings, Journal of the American Concrete Institute. November 1929, *Proceedings*, Vol. 26, p. 1.

†Assistant Chief Engineer, The Foundation Co., New York City.

by the exclusion from section two of the latter part of the first sentence: "and also all usual necessary and essential portions of a structure of this type that would commonly be made of plain or reinforced concrete, whether or not they are definitely shown on the plans or listed in the specification."

The second paragraph of section eleven, appears to me rather indefinite. Is the assumption that no bars shall be placed further apart than six inches correct? Does not this paragraph place some burden of design upon the contractor? Some designing engineers place reinforcing in concrete slabs resting upon the ground. This paragraph encroaches upon the design of reinforced concrete, it adds nothing to the quality of workmanship and should be eliminated from this specification.

I question the results which will be obtained by the application of the provisions of the second paragraph of section twelve wherein the oiling of forms is required after they have been kept continually moist after erection.

I agree with Mr. MacMillan's statement that good results can be obtained in placing concrete under water by means of special bottom dump buckets. The placing of concrete under water is not one which should be covered by a general specification for *ordinary* buildings. The purpose to be served by the under water concrete, the material upon which it is to be placed, and other considerations, render this feature one which should be covered more specifically and fully than by the statement that it shall be placed only by the tremie method.

BY J. E. LAMBIE* (BY LETTER)

I note it is suggested that concrete shall be *mixed at least one minute.*

Of course, this is O. K. for the old style batch mixer, but it is also obviously possible to get more actual mixing done in ten seconds than the old batch mixer can do in even two minutes, therefore if there is a quicker and better way, why not open the door wide for its use?

Perhaps if all concrete were made by the vigorous positive centrifugal force grinding, slicing and churning method we employ in our machine, there wouldn't be so many failures.

*President, Lambie Concrete House Corp., Cleveland.

Certainly it seems to me that any system that has received the intelligent attention and work and expense we have devoted and contributed to the art should be most carefully investigated before any codes are made that would prejudice the interest and use of such improvements.

In our testing a lot of concrete has been made and poured and some of it under most adverse conditions, to prove our theories in a practical way in the field, and there is yet to be recorded a single failure or job that has not stood up well and with big margins of safety and strength and appearance, even including some jobs on which we experimented with some little misgiving, based on council and precedent, which said the thing couldn't be done.

I don't mean by this that I would advocate using poor aggregates while good aggregates were available at reasonable cost, but there are times and places where the inferior aggregates can be used to advantage and still produce a quality product suitable for the purpose.

We have cast houses here from lake beach sand and gravel, also in Florida of the Florida shell sand, and every job that was ever turned out by our machines is A-1 quality concrete.

I would like to see this point of time for mixing so dealt with that it applies as intended to the particular type of machine being dealt with, and this does not apply in same way to my machine as it does to the batch mixer, for in the case of the batch mixer the speed of the cylinder is restricted to allow gravity to overcome centrifugal force, while in my machine we do not depend upon gravity and may run slow or speed up at will to hasten the process of mixing and the same is true of our pump conveyor apparatus, the speed of which may be regulated to suit the conditions.

BY JOHN G. AHLERS* (BY LETTER)

I am impressed by the fine work done in this specification.

It is very evident that the contractors', as well as the engineers' problems are in mind.

There are one or two little items on which I do not agree. The first, in article 10, prohibiting the use of reshoring. I assume that this clause could be waived where competent contractors

*Secy. and Treas., Barney-Ahlers Construction Corp., New York City.

were on the job who remove forms only where the concrete is capable of sustaining its own load, and in such cases you would allow reshoring to take care of any later, superimposed construction load.

Article 14, prohibits the use of twisted wire in applying patches. We find that twisted wire for small openings, such as heat holes, etc., is very helpful and does not cause any more deflection than forms supported by shores from below.

I suggest an addition in Article 26 for the inclusion of a steam line to blow out the snow and ice from the forms during winter weather construction.

BY K. H. TALBOT* (BY LETTER)

Attention is called to Article 19, Time and Mixing, in which one full minute is required to elapse between the time when all the material for any given batch is placed in the mixer and the time when the first concrete of that batch is discharged from the mixer. Results of tests made by Professor Talbot, lead us to recommend that this wording be changed to read "One full minute shall elapse between the time when all materials for any given batch, not including the water, is placed in the mixer and the time when the first concrete of the batch is discharged from the mixer." You can readily realize that the problem of distributing as little water as we are now using to a batch of the size required for a one-yard mixer, is not a simple one and that if you are to obtain that uniformity of concrete which is so essential to the success that you desire, consideration should be given to getting the best results inside of the mixer. If the water is put in too early, the first of the batch as received by the drum will take up a considerable amount and the last of the batch will not have enough; whereas, if it is allowed to enter the drum ahead of the material and continue to flow for some time after the material is in the drum, this will be entirely eliminated.

In Article 20, Conveying Concrete, and in Article 21, Placing Concrete, there is a question whether sufficient consideration has been given to the possibility of developing a mechanical means for placing concrete, which mechanical means can do it more expeditiously than by the use of wheelbarrows or carts—perhaps

*Director of Research, Koehring Co., Milwaukee.

the application of the belt conveyor or the boom bucket.

We have long felt that quality and uniformity, rather than methods, should be specified by engineers, leaving to the initiative of the contractor and the manufacturer the problem of developing equipment that will meet this requirement.

BY C. S. WAGNER* (BY LETTER)

Our feeling with reference to Article 20, is that the statement that "concrete may be conveyed by any means which will not result in segregation" should suffice and that it is both unnecessary and in a way unfair to further the foregoing statement with a direct prohibition such as: "it shall be transported in buggies or wheelbarrows to its final position in the forms."

We are certainly in accord with any steps which may be taken by anyone to the end that a concrete be produced which is the best concrete from what may be termed an economic standpoint. We do feel, however, that any body of engineers which goes beyond a stipulation as to the ultimate result which is to be obtained is taking action outside of their proper field of endeavor. The engineer certainly has the right to determine what specification requirements should be made, but it is felt that it should be left to the contractor to obtain the desired result as he best can.

It occurs to us that any other method of procedure serves to smother the initiative of both manufacturers and contractors who are endeavoring to further the use of concrete.

A specification such as the one under discussion would not only limit the use of chutes but would also limit the employment of belt conveying apparatus, a system of concrete handling which is undergoing considerable investigation at this time.

Commenting upon the last five lines of Article 20, we do not know just what it is intended that the specifications shall cover. Concrete would not move any considerable distance from the end of a chute in a horizontal direction and when it comes to the vertical drop section we can see no difference between dropping concrete from the end of a chute or from the edge of a wheelbarrow or concrete buggy. Perhaps the chuting side of the problem has not received the consideration which is merited and perhaps the committee is unaware that within recent months a new chute has

*Sales Manager, Insley Manufacturing Co., Indianapolis.

been produced, designed especially to handle dry concrete mixtures and that we have data which indicates that concrete having a slump as low as 2½ inches has successfully been handled through comparatively long chute lines with a complete absence of segregation.

It is and always has been our idea that the chute has more or less been made the goat and that the real solution of this strength of concrete problem lies at the mixer rather than in the conveying system. If concrete is correctly proportioned at the mixer and means provided to secure uniformity of the batches we feel very sure that good concrete will reach the forms irrespective as to whether chutes, wheelbarrows, buggies or concrete conveyors may be used as the conveying medium.

BY J. H. WASSON* (BY LETTER)

I suggest one change in this excellent specification. Paragraph 9 of Article 29 requires that "sidewalks and parking strips shall be laid on top of a plain cinder filling at least 5 in. thick." It is my observation and belief that cinders placed under sidewalks and parking strips often do more harm than good. When drains are not provided, which is usually the case, the cinders may act as a catch basin and increase the damage due to freezing, etc. Experience has proven that cinders are not essential. They add very materially to the cost and are not obtainable locally at many places where important structures are to be built. It would seem highly desirable from the standpoint of waste elimination in construction, that cinders should not be specified for use under sidewalks and parking strips in a general specification such as this one.

BY STANTON WALKER† (BY LETTER)

MY COMMENTS refer only to Sections 6 and 7 covering aggregates and are in two parts, as follows:

1. Discussion of authority of Committee 502 to prepare specifications for concrete aggregates.

2. Comments on certain features of the specifications which that committee has proposed.

*Engineer Representative, Peerless Cement Corp., Detroit.
†Director, Engineering and Research Division, National Sand & Gravel Assn., Washington, D. C.

1—SCOPE OF COMMITTEE 502

The title of Committee 502 is "Mixing and Placing Concrete in Buildings." This title does not indicate that the preparation of specifications for concrete aggregates falls within its scope. The Board of Direction of the Institute evidently did not intend that it should, for it established Committee 201, Aggregate Specifications.

Committee 502 has proposed specifications for fine and coarse aggregate differing from the recommendations of old Committee E-5—now replaced by Committee 201. Such duplication leads to confusion and seriously weakens the influence of the Institute. This is not the first instance of more than one aggregate specification in the Institute *Proceedings* and probably there are similar instances in the case of other materials. I recommend strongly that the proper coordinating committee give consideration to the problem of avoiding conflicting recommendations from the Institute.

2—COMMENTS ON AGGREGATE SPECIFICATIONS PROPOSED BY COMMITTEE 502

The specifications for fine and coarse aggregate proposed by Committee 502 differ radically in form from the recommendations of Committee E-5. This feature within itself, is not, of course, an objection. However, certain of the clauses are not, it seems to me, compatible with the requirements of a general specification for nation-wide use, nor do all of them permit of ready interpretation.

My comments on certain features of the specifications follow:

Section 6, line 4. "Or if from a new source, shall be thoroughly tested for soundness and permanence." Some hint as to the method of carrying out such tests would be helpful.

Section 6, line 5. "It shall have a fineness modulus of not less than 2.75." Many good concrete sands have fineness moduli less than 2.75. With few exceptions (perhaps two or three) state highway specifications for concrete sand permit a lower value than this and I believe that it will be generally admitted that such specifications are among the most representative of good practice. Only one or two states express their specifications in terms of fineness modulus but a study of the grading requirements permits an approximation of their limiting values. The approximate

lower limits, computed from specifications, for a number of typical states picked at random follow: (a) Kansas, 2.4 (stated in specification); (b) Indiana, 2.45; (c) Illinois, 2.40; (d) Michigan, 2.55; (e) California, 2.90 (exceptionally coarse); (f) Arkansas, 2.40; (g) Pennsylvania 2.30.

I shall be very glad to furnish further information along these lines for all states and for other specifications if the committee desires. I can say, confidently that a limiting value of fineness modulus of 2.75 would eliminate many excellent sands which are now being used in concrete with complete success. It would be well also to include a maximum limit of fineness modulus.

Article 6, line 6. "It shall not contain in excess of two per cent of dust passing the 100 sieve when thoroughly dried." This requirement is inconsistent with generally accepted national and local specifications. It is much more rigid than any state highway specification, and dust is probably more injurious in concrete highways than in building construction. Further, screening does not represent an accurate method of determining dust; a decantation test should be used. Also the rigid limit on this sieve is incompatible with the generally expressed desire to secure more of the finer sizes in sand—particularly "minus 50."

Article 6, line 7. "It shall be free from organic matter, etc." A more acceptable and generally used phraseology would be "free from injurious amounts of, etc."

Article 7. General comments somewhat similar to those given for Article 6 apply here. However, I will refer only to the limiting value of fineness modulus of 5.5. It is entirely too low for aggregate meant to be graded up to 1 in. Consideration of the grading which would produce a fineness modulus as low as this will show that it would be necessary to include a considerable quantity of sand. For example, the following sieve analysis represents about as coarse a grading as would occur for a fineness modulus of 5.5 with a top size of approximately 1 in.

I believe that the above will be recognized as a rather unsatisfactory grading for coarse aggregate. A lower limit in the neighborhood of 6.3 or 6.5 would be more nearly correct. An upper limit should also be stated.

Sieve No.	Percents Retained
100	100
50	100
30	100
16	100
8	70
4	50
⅜	20
¾	10
1	0
Fineness Modulus	5.50

Much might be said by way of discussion of general clauses relating to quality and impurities which might be included in specifications for fine and coarse aggregates. It seems to me, however, that these are covered as well as present information permits in the specification proposed by Committee E-5. I believe it will be agreed that, if there are objections to E-5 recommendations they should be cleared through that committee.

ARTHUR R. LORD, AUTHOR-CHAIRMAN COMMITTEE 502, PRESENTING REPORT AT 26TH ANNUAL CONVENTION

This proposed specification, the work of Committee 502, has been printed in the November JOURNAL of the Institute. Nothing would be gained by reading it here, and much time and weariness will be saved by *not* reading it.

The purpose of the Advisory Committee, as endorsed by the Board of Direction, in calling for the preparation of this and similar specifications of a type new to Institute work, was to provide a ready-made specification which an engineer or architect may incorporate as a complete reference document in his typewritten specifications. Just as he has long called for his cement and his reinforcement to comply with the proper specifications of the A. S. T. M., he may now call for his entire job of concrete work including all the materials, to comply with this specification. As with any ready-made suit, he must often make a few minor alterations to get a perfect fit. Very few *changes* will be required, but in special cases *additions*, to take care of unusual circumstances or requirements, may profitably be made. The note

addressed "To the User" gives the necessary instructions for such special cases in which additions may be desirable.

It is not easy to present so dry and impersonal a thing to an audience, even of engineers and contractors, in a way that will be helpful. I had thought of telling you a few of my experiences and observations on concrete work in the American city of Ignoravia. I feel quite sure that no one here today is familiar with this hustling town. Hence my experiences should have all the exotic flavor of foreign travel, even though this city is very much a part of the United States and these specifications would be available for use there. Had I carried out this plan, I would have said:

"In Ignoravia, they do things differently. It begins at the very beginning. Where you, gentlemen, are most particular as to the choice of your materials, even esteeming one brand of portland cement above another, in Ignoravia they accept *anything* that is sent to them and seem grateful to get it. In this strange city, I have seen cement sacks in which, from exposure to the weather, much of the cement had hardened. There were lumps as big as your two fists, which went through the mixer without breaking, but such cement was used without a qualm. Sometimes the workmen would throw out these lumps, as they were hard to push between the bars or because they bothered the cement finishers, but no one ever seemed to be concerned over the cement thus thrown overboard. (Art. 5) The material supply firms in Ignoravia seemed to swap orders at the least excuse, and even the same dealer would send widely different materials at various times. (Art. 9) Then the contractor would struggle with the concrete, now sloppy, now stiff, blocking the chutes and showering with concrete the formwork and reinforcing below, causing sand streaks and honeycomb (to be later expensively patched) in their finished work. How hard a task their poor underworked heads made for their poor overworked hands! How thankful I feel for the progressive, brainy contractors with whom I rejoice to work everywhere, save in Ignoravia!

"When, in Ignoravia, I foolishly suggested *testing* the *cement*—an unheard-of waste of time and money in that city—the leading cement manufacturer told me to take samples from sacks that were being filled for immediate shipment to a job in Oklahoma.

He thought it most unreasonable that I should want to test samples of the actual cement that was going to be used on this job, or that I should refrain from using the cement until the results of the seven-day tests were known! (Art. 5) He told me not to worry over reports of rejected Ignoravia cement on certain road work or other similar gossip—such thoughts lead to hardened arteries, sleepless nights and other entirely unnecessary unpleasantries. I am sure that by this time, you begin to appreciate what a strange city I am describing. How impossible that such things should occur in New York or Chicago or in your own home town!

"In Ignoravia, however, it is but a beginning! The Ignoravians read voraciously all the illuminating papers and reports of the American Concrete Institute and of the Portland Cement Association. I found myself widely known and highly honored for even my small contributions. But for all their zest in reading, little of it finds any practical application on their jobs. They are most likable, entertaining, friendly folks—but unbelievably slow to use the new knowledge laid ready to their hands. Not that they doubt or question it—they accept it as gospel—but they just seem to lack the necessary connection between their receptive heads and their habit-bound hands. I fear for my hard earned reputation for veracity when I tell you that, in Ignoravia, architects and engineers still commonly specify, contractors still *commonly* use, *1:2:4 concrete!* (Art. 17, 18) And water! They discuss endlessly all the fine points of water-cement ratio, but they use such "soup" as you and I have hardly seen elsewhere in ten enlightened years. It reminds me of that scene in Pilgrim's Progress when Christian attempted to help three fellow travellers. 'Simple said, "I see no danger;" Sloth said, "Yet a little more sleep;" and Presumption said, "Every fat must stand on his own bottom."' It's that way in Ignoravia.

"And then again, they would carefully place their reinforcing steel on bent straps made of *soft steel*, intended to space the bars automatically and to hold them at the right height, just as our fine spacing and supporting accessories do. But when they walked about, these soft steel devices commonly flattened out and let the steel rest flat on the forms. (Art. 11) Then they would shake their heads sadly and murmur 'too bad!' and make

haste to cover them up with concrete. It was most disturbing to see big, full grown men act so like children!

"I have seen—in Ignoravia—workmen oiling the forms *after* the reinforcing steel was in place (Art. 12), coating the reinforcement with the oil, apparently unable to act upon so simple an idea as that this oil would destroy the very bond on which the coaction of the steel and concrete depends! I saw—in Ignoravia—a batch mixer with the materials going in at the charging side and concrete being drawn from the discharge chute at one and the same instant! (Art. 19) I saw the mixing water put in by guess by a man who had many other things to attend to, and who shut off the water when he happened to think of it. (Art. 16) I saw strong, energetic workmen trundling heaping wheel barrows to the mixer and I saw weak, lazy men with barrows barely half full at times. There was frequently no intelligent attempt to determine even approximately the amount of sand and stone in a batch or to keep it constant in successive batches.

"It is useless for us to attempt to understand them. Consider for example their treatment of concrete, after it has been placed in the none-too-good manner that I have described. They have read approvingly and understand fully that *all* concrete must have moisture continuously for its proper curing, but they see no inconsistency between this belief and a practice that gives *part* of the concrete curing water and other parts none. Columns and spandrel beams are left without water, and after a day or so, without even shelter from the sun's drawing rays! If it seems desirable to set apart an area for carpenter work, or the like, on top of a freshly placed slab, no covering or water is given to this area!

"Ignoravia has an invigorating climate; cold winters, hot summers, many and sudden changes in temperature. I have been particularly disturbed by the nonchalance with which they regard the well known perils of carelessness in cold weather concreting. They would make the contractors whom you and I know, elsewhere, shudder in their sleep, by the risks they take. Frequently the salamanders are not started until some time after the concreting is under way, nor are the tarpaulins in place in advance. The warm concrete is permitted to thaw out any ice or snow in the forms. (Art. 24) Workmen sometimes are dimly

seen trying to place concrete in blinding, choking smoke from starting salamanders! I have actually seen cases where the tarpaulins have been so poorly fastened as to tear loose and leave large openings in the enclosure below the new slab. No one seems perturbed by such events! No one hastens to close the breach. They take down the tarpaulins in zero weather after one or two days, and move them elsewhere. Is it any wonder that most of the concrete failures reported, are at Ignoravia?"

But I have decided not to present the matter in this way. You would penetrate the disguise too easily. You would recognize only too readily that two jobs on the same street, in the same block, in Chicago, or New York, may have a third located in the heart of Ignoravia midway between them. When we write such a specification as we are now considering, we cannot be sure that it will not be used on work in Ignoravia. In that case, you will need all of our provisions, and a diligent inspector to enforce them. But do not think that we have given big hostages to chance in this document. We have intended to require only those precautions necessary to the assurance of first class concrete work under normal working conditions. If you will show me wherein any clause or paragraph is unnecessarily severe, I will gladly second your motion to modify it properly. This specification should not go beyond the protection of the owner's right to a first-class job. There is no right to burden the contractor needlessly, that we need recognize. But we do need to recognize fairly that the practice of concrete placing has lagged far behind the theory, and that such a specification as this, must insist on suitable practice to insure proper results. We must use a specification which is *worthy* of a good job. When anything goes wrong with the machinery and the lawyers are called in, happy is the architect or engineer with such a specification.

F. R. McMillan has stated the simple requirement—that our work shall result in a *plastic homogeneous mix*, plastic during placing, homogeneous both during and after placing. No contractor should be content with "*peace without victory*" when the adversary is so slight! In fact, success is assured if he will but honestly follow out in a common sense manner, the simple instructions contained in this specification. As Josh Billings said: "*It ain't the things we don't know that makes such fools of us, but a*

whole lot of things we do know that ain't so!" We have plenty of information as to what to do, what not to do. We only need to free ourselves of a lot of accumulated bad habits on the job and throw off a lively dread of difficulties imagined rather than real. To paraphrase another well known quotation: *"Good concrete is not made by machines and specifications but by MEN in spite of machines and specifications."* Our biggest practical problem is to get the men on the job to assume and discharge their plain responsibility for the quality of the concrete they produce. As long as the material dealer knows, when I reject a truck load of dirty aggregate, that he can drive around the corner and have it gratefully accepted by leading firms of architects in Chicago, he will continue to show little interest in furnishing better and more uniform material.

After there has been proper chance for discussion, for questions and answers, for explanations that may be desired, Mr. Chairman, I would appreciate your kindness in putting to vote the following motions:

In "To the User" add a paragraph, between the second and third paragraphs from the end as follows:

For this structure the reinforcing steel furnished by this contractor shall be Intermediate Grade New Billet/Rail Steel (Strike out one) in accordance with Article 2, Specification No. 503.

6. FINE AGGREGATE. (Substitute new wording.)

Fine aggregate for this work shall consist of well graded natural or artificial sand, or other approved inert materials with similar characteristics, taken from sources that have furnished satisfactory materials for previous concrete work for several years, or if from a new source shall be thoroughly tested for soundness and permanence. It shall comply with the provisions of the Tentative Purchase Specifications for Concrete Aggregates, E5-A-26T, (or subsequent serial) of the American Concrete Institute. In applying these provisions the sieve analysis of dried aggregate shall show as follows:

Passing No. 4 sieve—not less than 85 per cent.
Passing No. 50 sieve—between 5 and 30 per cent.
Passing No. 100 sieve—not more than 5 per cent.
Fineness Modulus—not less than 2.50

and the weight of clay and silt removed by decantation shall not exceed 3 per cent.

Fine aggregate shall be so stored and handled at all times as to remain free of all foreign material and separate from other aggregates until placed in the mixer.

7. COARSE AGGREGATE. (Substitute new wording.)

Coarse aggregate for this work shall consist of crushed stone, gravel, air-cooled blast-furnace slag, or other approved inert materials of similar characteristics, taken from sources that have furnished satisfactory materials for previous concrete work for several years or if from a new source shall be thoroughly tested for soundness and permanence. It shall comply with the provisions of the Tentative Purchase Specifications for Concrete Aggregates, E5-A-26T (or subsequent serial) of the American Concrete Institute. In applying these provisions the sieve analysis of dried aggregate shall show as follows:

Passing 1-inch sieve—not less than 95 per cent.
Passing No. 4 sieve—not more than 10 per cent.
Passing No. 8 sieve—not more than 5 per cent.
Fineness Modulus—between 6.30 and 7.50.

The weight of slag shall not be less than 65 lb. per cu. ft. The weight of soft, friable, thin, elongated or laminated pieces shall not exceed 3 per cent.

Coarse aggregate shall be so stored and handled as to remain clean and well graded at all times and shall be kept separate from other aggregates until placed in the mixer.

Art. 15, line 5: insert after words "rotary batch mixer" the added words, "(or, with the approval of the Architect or Engineer, other approved mixing device operated a sufficient time to give equal results)".

Art. 16, lines 1 and 2: strike out the words "measured by weight or volume" and substitute the words "weighed or measured by volume."

Art. 19, end of first sentence, add: "except that a portion of the mixing water may be introduced during the first ten seconds of the mixing time."

Art. 22, at end: add a new sentence as follows: "The added bars shall have a cross sectional area not less than .0025 of the area of the member cut by the construction joint."

Art. 25, line 1: insert the words "or steam" after the word "water."

Art. 30, line 10: after the words "tremie method" add the words "or by means of an approved bottom-dump bucket."

Art. 30, line 15: insert new sentence as follows: "Bottom-dump bucket shall be so constructed that bottom must rest on prepared surface or on surface of concrete already placed, before it can be discharged."

Readers are referred to the JOURNAL *for Sept. 1930 for discussion.*

Discussion of Report of Committee 401

"Portland Cement Stucco Finishes"*

DISCUSSION BY SAMUEL WARREN (BY LETTER)

In the report of Committee 401, on Portland Cement Stucco Finishes, in the November JOURNAL there appears on page 38 under the head of "Discussion" the following sentence: "Mixtures that were quite satisfactory prior to this time cannot be used for modern textures." I beg to differ from this statement.

The mixture thus condemned is the old standard mixture of 1 part by volume of cement, 3 parts by volume of sand and 10% of the weight of cement (20% by volume) of hydrated lime. It has been the writer's experience that such a mixture, if the sand be normally well graded, will produce any desired texture. But with the important proviso that the suction of the scratch coat be correct. In fact the writer has produced most attractive textures with a harsh angular sand, using the above proportions without the use of any lime. Just a 1:3 mixture of cement and sand. The whole secret lies in wetting down the scratch coat so that only sufficient suction is left to allow the finish coat to be applied without "bagging."

The call for great plasticity in finish coats comes from the practice of applying the finish coat to almost bone dry undercoats. Such must cause rapid absorption from the finish coat and consequent loss of strength through improper hydration of the cement.

An actual instance is of interest. A contractor attempted a rock dash portland stucco job. The wall construction was brick. Over this had been applied a base and a scratch coat. With one man applying the finish coat and another applying the dash, it

*Journal of the Am. Concrete Institute, Nov. 1929—*Proceedings*, Vol. 26, p. 29.

was impossible to get the dash to imbed. Examination showed a "suction" set of the finish coat in about 45 seconds, although water had been applied to the scratch coat with brushes. A hose was then turned on the wall and when the scratch coat had been *properly* wet down, it was impossible to imbed the dash up to 25 minutes later. (The actual limit of time was longer but was not measured).

The same idea is true in applying textural finishes. Excessive plasticity in the mix is not required, but the suction of the base coats must be reduced to a point where it allows the applied finish coat to *remain* plastic until the texture desired has been secured.

The writer often blushes at the atrocities that pass as textures, when he realizes that his efforts in this work led to such results.* A "good" texture is one that shows the method of application. A "poor" texture is one produced by fiddling with the still plastic finish coat once it is on the wall. It is the difference in effect produced in a timber, hand-hewn from a log and a square timber nicked with a hatchet to try to get the effect of hand-hewn work.

Going back to the original argument, I agree with the committee that the finish coat should be as high quality as the base coats and there is no reason from practical standpoint why it should not, except the refusal of the mason properly to wet down the base coats.

*Samuel Warren is now a toy manufacturer, (Petertoy) at 184 Sullivan St., N. Y. C., who could not resist this interesting "rise" to his one time specialty—stucco. As manager of Atlas White department, Atlas Portland Cement Co., he had much to do with stucco textures. He "went to school" to the plastering trade with stucco textures in mind; emerged to teach those from whom he learned. In the uniform of his trade he showed architects and craftsmen how to do it with normal mixes and without the inartistic exaggeration which has spoiled so many surfaces. He showed motion-pictures of stucco application to the Institute in 1925. His discussion appears in *Proceedings*, Vol. 21. 1925 Page 197. He once said, half, at least, in jest, the arm of the experienced plasterer gets too stiff for any motions but habitual ones and the way to get pleasing surfaces of casual, not studied, irregularity, is to let the plasterer do the mixing and the hod-carrier put it on.—EDITOR.

Discussion of Report of Committee 202

"Variations in Standard Portland Cements"*

DISCUSSION BY G. M. WILLIAMS†

The report which Mr. Bates has prepared on Variations in Standard Portland Cements emphasizes the variable properties of the material which most users are accustomed to consider as fixed in qualities and properties. The retention of a single standard specification over a period of years has tended to establish and fix the idea that the different portland cements produced from dissimilar raw materials of the same general composition will give the same results in use. The seemingly complete and rigid specification has contained nothing which would suggest to the cement user that cements do differ in such properties as strength, permeability, and expansion when made into mortars and concretes, and that knowledge of the chemistry of cement is far from complete. That portland cements, produced under this single specification, are not the same chemically or physically has been apparent to testing engineers and cement chemists, but as Mr. Bates points out, available test data to establish these differences are very meager.

Compressive strength has been and probably will continue to be the controlling factor in the use of the great bulk of the cement produced but even for such uses other factors, such as watertightness, volume change, due to temperature and moisture, and resistance to the disintegrating effect of solutions may be involved and the useful life of a structure may be greatly reduced by lack of knowledge of the relative ability of different portland cements to stand up under such exposures.

---

*By P. H. Bates, Author-Chairman, Committee 202, Journal of the American Concrete Institute, November 1929—*Proceedings*, Vol. 26, p. 65.

†Prof. of Civil Engineering, University of Saskatchewan, Critic Member, Committee 202.

No doubt in time a full knowledge of the conditions to which a cement will be subjected in use will permit a specification being written which will result in the selection of the best cement for the particular use but much work remains to be done in the chemistry of cement before this can be done fairly and intelligently. Physical tests will continue to point out differences in cements and result in selection of the fittest for particular uses but the complete and satisfactory solution of the problem is in the hands of the physical chemists.

The writer has at times noted some of the variations which the author has pointed out but has felt that the explanation of, and means of eliminating, the undesirable factors must await an extension of the knowledge of cement chemistry. For example the permeable qualities of a cement mortar or concrete made with any particular cement are not so easily expressed as would be indicated by much of the published data. The permeable qualities change with age, the rate depending upon exposure to moisture. A 1:6 proportion concrete in thin sections may be impermeable under a high head after water storage at 28 days, whereas the same specimen tested a year later after exposure to varying wet and dry conditions may be very permeable. No doubt there is a change in the colloidal condition in the mass with change of moisture content, but the factors involved such as constitution of cement and exposure in commercial work greatly complicate the problem of expressing permeability qualitatively or comparing this quality under all practical conditions.

Of all the variations, that of compressive strength is no doubt the one best established and measured by test data. The differences in strength shown by the author are probably magnified somewhat, due to their being the averaged results from many laboratories, but the writer has seen similar variations obtained in a single laboratory. Recent work by Thorvaldson at the University of Saskatchewan and Miller at University Farm, St. Paul, Minn., has established the wide differences in the resistance of portland cements to the disintegrative effect of sulphate waters. Here again physical tests will serve to distinguish between good and bad but the determination of the cause is dependent upon the physical chemist.

BY P. H. BATES AUTHOR-CHAIRMAN, COMMITTEE 202, (INFORMALLY PRESENTING REPORT AT 26TH ANNUAL CONVENTION)

The paper does not bring out anything striking or unusual, except that it does emphasize the vast gaps in our knowledge of portland cement, and consequently in concrete. We must never forget that the use of concrete as a commodity is based alone upon the *cementing* of the *cement*. As a consequence you cannot have concrete unless you have the cement, and if it varies in its properties, of course the concrete will vary in its properties. I just want to stress one thing, as an aside, but, I think, to the point: the tendency that has developed very recently in swinging around and emphasizing in all our investigational work, the fact that the material in concrete that should be studied is this cement paste, which again is largely the cement. It proves very conclusively that we move in cycles; we go around and around, and at the present time we have again run around that little circle. About 1909 or 1910, when the government, with the assistance of the cement manufacturers, was maintaining a laboratory in Atlantic City, my former colleague, Mr. Wig, and myself, had the rashness to investigate cement as cement; in other words, we took the cement and carried out certain researches where it alone was studied. I recall most distinctly the tremendous criticism which arose—to think that any conclusions could ever be drawn from investigating cement alone—and applied to concrete. That is just what we are doing now, today, again, for the cement paste is the factor that is being so very much stressed as the controlling factor in concrete. Possibly many years from now, we may have another paper on variations in standard portland cements—it is quite likely.

BY D. D. MCGUIRE*

May I offer some information in support of Mr. Bates' statements? We have a research project going on testing all our sand with the different brands of cement we use, and I find with the same sand and same water-cement ratio, variations in strength from 84 to 107. One thing peculiar is that while that variation may exist at seven days, it sometimes straightens out with some

*Tennessee State Highway Dept., Nashville.

sand in 28-days. In other words, the variation may be either in 7 or 28-day tests. These data have led us to believe that the most important thing in concrete is the mortar, and we are putting more stress on designing concrete from the water-cement ratio and the sand-cement ratio, considering the brand and types of material used, than any other theory of design. Our data are quite definite that we do have a distinct difference in the relation of brands of cement to the sand.

BY L. H. KOENITZER*

In the state of Kansas we are studying 19 different brands of cements. Of these 19 brands, 15 are standard portland cements. Most of these cements are used in the state of Kansas in highway construction work, and most of them are manufactured either in Kansas or in adjoining states. This report will not be finished for several months yet. We have found, though, from preliminary work, that one cement may require, we may say, a water-cement ratio of five-tenths; another cement may require a water-cement ratio of six-tenths; that is, to give a maximum density in the mortar. We are using Ottawa sand and a local sand throughout the experiment, on the basis of one to three and five-tenths absolute volume. In view of Mr. Bates' report, it might be of interest to know how our standard tests came out. I find in summarizing the 15 standard portland cements, that we got an average strength for seven days of 322 lbs. per sq. in. Mr. Bates has 290 lbs. per sq. in. so we are about ten per cent higher. Our 28-day test gave us a strength of 414 lbs. per sq. in. Mr. Bates' reports 390, or about six per cent variation. Our laboratory has recently been gone over by the Cement Reference Laboratory of Washington, D. C., and there were no radical mistakes being made in the laboratory, so I am inclined to think that we might add to Mr. Bates' 32 cements the 15 we have studied. Three of these 15 are reported in the 32, so Mr. Bates report might be concluded to be an average of 45 cements.

*Kansas State Highway Dept., Manhattan, Kans.

ABSTRACTS

of the current literature of cement and concrete

PREPARED UNDER THE DIRECTION OF THE
AMERICAN CONCRETE INSTITUTE
COMMITTEE ON ABSTRACTS

J. C. WITT, Chairman, (*Materials*)
H. F. GONNERMAN (*Properties of Concrete*)
F. E. RICHART, (*Engineering Design*)
REXFORD NEWCOMB (*Architectural Design*)
THEODORE CRANE (*Field Construction*)
W. D. M. ALLAN (*Shop Manufacture*)

EDITED BY DWIGHT F. JENNINGS

ABSTRACTORS THIS MONTH

F. O. ANDEREGG, Senior Industrial Fellow, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

C. BACHMANN, Editorial Dept., *Concrete*, Chicago, Ill.

A. E. BEITLICH, Whiting, Ind.

A. A. BRIELMAIER, University of Illinois, Urbana, Ill.

MILES N. CLAIR, Vice-Pres., The Thompson-Lichtner Co., Boston, Mass.

H. J. GILKEY, Associate Professor of Civil Engineering, University of Colorado, Boulder, Colo.

A. J. HOSKIN, Editor, *Pit and Quarry*, Chicago, Ill.

F. H. JACKSON, U. S. Bureau of Public Roads, Washington, D. C.

DWIGHT F. JENNINGS, American Concrete Institute, Detroit, Mich.

V. P. JENSEN, University of Illinois, Urbana, Ill.

J. J. LANDY, Associate Editor, *Rock Products*, Chicago, Ill.

D. E. LARSON, University of Illinois, Urbana, Ill.

REXFORD NEWCOMB, Professor of the History of Architecture, University of Illinois, Urbana, Ill.

F. E. RICHART, Research Associate Professor of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill.

N. H. ROY, University of Illinois, Urbana, Ill.

Stanton Walker, Director, Engineering and Research Division, National Sand and Gravel Association, Inc., Washington, D. C.

G. M. Williams, Professor of Civil Engineering, University of Saskatchewan, Saskatoon, Saskatchewan.

C. R. YOUNG, Professor of Civil Engineering, University of Toronto, Toronto, Ont., Canada.

MATERIALS

ADMIXTURES

Concerning Admixtures. ROY CROSS. *Concrete*, Jan. 1930, V. 36, No. 1, p. 37.—The term "admixture" has been applied to a variety of substances having considerable variation in properties, but in general it is applied to powdered admixtures designed to improve the handling of concrete. The following outline suggests, in order of importance, the required characteristics of acceptable admixtures: Admixture should (1) have the property of imparting improved workability to the concrete; (2) result in better concrete in terms of uniformity of the mixture, lack of segregation, etc.; (3) impart all possible desirable properties with minimum quantity of materials; (4) have no deteriorating effect on concrete; (5) be available at a cost that will not materially increase cost of concrete.—C. BACHMANN

Lime and hydrate in 1929. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 113.—Significant developments of the past year in review. Five illustrations. —J. J. LANDY

AGGREGATES

The influence of the leaching of testpieces during the water storage. G. KATHREIN. *Zement* (Germany) Jan. 1930, V. 19, No. 1, p. 2-3.—Experiments were made to study the influence of the structure of aggregates on the value of mortars. The process of swelling and shrinkage of testpieces by storage in water under different conditions was observed. The testpieces were made from 1 part of portland cement or high alumina cement and 1 part of different aggregates composed of equal parts of 0.2-0.086 mm. and 0.086-0.0 mm. particles. The aggregates were quartz, granite, quartz porphyry, pumice, trachyte, hornblende granite, basalt, serpentine, limestone, marble and kaolin. The testpieces were stored one week in moist air, 9 weeks in dry air, 4 weeks under water, 6 weeks under lime-water and finally 3 weeks in water. The temperature was 20° C. The variations in length were measured and it was found, that swelling took place in lime-water while the samples shrank in ordinary water. The variations of the samples with high alumina cement were smaller than those with ordinary portland cement.—A. E. BEITLICH

The concrete aggregates. OTTO GASSNER. *Zement* (Germany), Jan. 1930, V. 19, No. 1, p. 9-13.—Specifications for different concrete aggregates are given as natural rock, volcanic rock, cinders and blast furnace slag. The different gradings, their chemical properties and their behavior in heat and frost are described.—A. E. BEITLICH

Uniformity of specific gravity and absorption tests of aggregates. D. O. WOOLF. *Nat. Sand Gravel Bul.*, Jan. 1930, V. 11, No. 1, p. 13-14.—(Reprinted from *Public Roads*, Oct. 1929.) Comparison of results of different absorption and specific gravity tests on the same aggregate have disclosed wide differences. In order to determine the cause of these differences, tests were carried out by the Bureau of Public Roads on six or seven different samples of each of seven different materials. Different tests were made on the same sample by the same operator and by different operators. The author concludes that it is the selection of the test sample, and not the test method, which is responsible for the great variations obtained with a single material.—STANTON WALKER

The terrazzo. "Der Terrazzo." ALFRED BOHNAGEN. (Germany), 1929, Konrad Wittwer, Stuggart. Reviewed in *Zement* (Germany), Jan. 1930, V. 19, No. 3, p. 64.—The book illustrates the development, manufacture and applications of terrazzo. It describes the raw materials, their advantages and disadvantages.—A. E. BEITLICH

Crushed stone in 1929. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 94-98.—A review by sections and states giving in detail the principal technical and economic trends. Six illustrations. —J. J. LANDY

Sand and gravel in 1929. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 99-106.—A detailed review of the sand and gravel industry in the United

States, by districts and states. Technical and financial developments are discussed. Six illustrations.—J. J. LANDY

Bureau of Public Roads investigations on concrete and aggregates. F. H. JACKSON. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 144-145.—Concrete investigations include (1) Laboratory study of the effect of type and gradation of coarse aggregate upon the strength of concrete, (2) study of concrete paving mixtures for the purpose of determining the maximum amount of coarse aggregate which may be employed when the uniformity of the grading of the coarse aggregate is carefully controlled by measuring it in three separate sizes, and (3) lightweight concrete for floors of long span bridges. Tests made include determination of the strength of plain and reinforced slabs, the bond strength of embedded steel, and the density, durability, and elastic properties of the concrete. Aggregate studies made to determine effect of shape of grain, surface texture and mineral composition, upon concrete strength.—J. J. LANDY

France Stone Co.'s research laboratory work in 1929. H. F. KRIEGE. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 146.—Tests reveal crushed stone should be judged on merits rather than source. Work continued on the effect of gradation of aggregates on the quality of concrete indicate that arbitrary separations lead to fallacious results. Tests on "combined" aggregate (fine plus coarse) concrete yield more significant details as regards concrete. —J. J. LANDY

Progress in study of quarry costs. J. R. THOENEN. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 135-136.—Simplified and standardized cost accounting will bring about material economies which can be reflected in lower priced products.—J. J. LANDY

Sand and gravel production in Canada—1928. *Can. Eng.*, Jan. 14, 1930, V. 58, No. 2, p. 136.—Production of sand and gravel in Canada in 1928 reached 28,102,917 tons valued at $5,809,431. Imports consisted of 588,311 tons principally from the United States and exports totalled 797,111 tons. There were 493 operators engaged in the industry.—G. M. WILLIAMS

Slag in 1929. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 118.—A general review of the industry. One illustration.—J. J. LANDY

Survey of limestone and phosphate situation in the Midwest States. J. R. BENT. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 119-123.—Substantial increases in these materials recorded in 1929. Value of different limestones and varying degrees of fineness discussed.—J. J. LANDY

Research in aggregates in 1929. EDMUND SHAW. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 125-127.—An abstract of detailed descriptions and tests concerning the effects of aggregate characteristics (physical and chemical) on resulting concrete.—J. J. LANDY

Research in sand and gravel in 1929. STANTON WALKER. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 128-130.—Principal activities of the National Sand and Gravel Association laboratory have been in regard to studies of sand and gravel as concrete aggregate. The more important problems on which work has been carried out are: (1) Effect of the addition of finer sizes, such as pea gravel, to coarse aggregate on the strength and economy of concrete. (2) Effect of variations of the grading of sand and gravel, within specification limits, on its concrete-making properties. (3) Effect of variations in maximum size of coarse aggregate on the strength of concrete. (4) Effect of grading on void content of sand and gravel and the consequent effect on strength and economy of concrete. (5) Effect of flat particles on concrete-making properties of gravel. (6) Studies of methods of measuring the quality particles. (7) Studies of effect of mineral composition and shape of particles of aggregates on their concrete-making properties. Four tables. —J. J. LANDY.

Developments in the concrete and aggregate industries. P. J. FREEMAN. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 130-132.—Review indicates definite progress in knowledge pertaining to uses of cement and aggregates. Attention is called to the increasing amount of investigations and tests under way and the growing needs

of durable surfaces for airport runways and low cost highways.—J. J. LANDY

Research in the National Crushed Stone Association laboratory. A. T. GOLDBECK. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 133-134.—Major projects completed in laboratory in 1929 included: (1) The effect of voids in crushed stone on the strength or properties of resulting concrete. (2) Comparative tests of crushed stone and gravel, the purpose of which is to attempt to develop a means for the design of concrete which will have a given beam strength irrespective of the type of aggregates used. (3) Investigations of the soundness of stone which have developed the fact that the sodium sulphate test is a very unsatisfactory one and it is hoped to substitute for it a freezing and thawing test. (4) Studies of stone screenings for the purpose of developing a greater market for them. (5) Investigations of flat and elongated pieces to find out whether specifications requiring not more than 5% of such pieces are defensible. (6) Special investigations for individual producers. (7) Effect of dust-coated stone on the strength of concrete which have shown that dust coatings up to 5.7% have very little effect on the strength of concrete, and that after one year test concretes containing dusts show fully as high strengths as those without dust.—J. J. LANDY

Why consolidations in the crushed stone industry? CHARLES W. LOVELL. *Rock Products*, Jan. 18, 1930, V. 33, No. 2, p. 30-32.—Analysis shows economy in operation and management possible through efficient mergers. Five illustrations.—J. J. LANDY

Rock products plants—details of design and equipment. Part 1. HUGO W. WEIMER. *Rock Products*, Jan. 18, 1930, V. 33, No. 2, p. 41-43.—Typical rotary screen drives, including belt, belt and chain, open gear and direct drives. Eight diagrams.—J. J. LANDY

A modern idea in gravel plants developed for results. *Rock Products*, Jan. 18, 1930, V. 33, No. 2, p. 44-46.—New plant at Fort Worth, Texas, produces large tonnage of many sizes of aggregate using vibrating screens for separation. One illustration.—J. J. LANDY

CEMENT

The setting and hardening of portland cement under the influence of water-soluble admixtures. A contribution to the question of hydraulic hardening. H. W. GONELL. *Zeitschr. angew. Chem.* (Germany), Nov. 1929, V. 42, No. 47, p. 1087-91.—The influence of several solutions of sugar, copper chloride, lead nitrate and sodium carbonate on the setting and hardening of portland cement was studied by means of test pats, thin sections, and microscopical examination of the cement mixture. The following conclusions were drawn: A normal setting process can take place only when both crystalline and colloidal compounds are formed. The presence of crystals of certain amounts and form (calcium hydrosilicate, calcium hydroxide and calcium hydroaluminate) are essential for the normal setting and hardening in the later ages. The hardness is due to the crystalline material, while the colloidal gel serves as a glue between the clinker particles and the crystals. In later ages the gel hardens in consequence of a crystallization and a withdrawal of water. The admixtures cited above retarded setting and prevented the setting when only or preponderant formation of gel took place. However, the samples hardened later when the pieces were not disintegrated. When the formation of crystalline material is preponderant, as in the case of Na_2CO_3 as admixture, the setting process is accelerated, but the later strength is less than that of samples with normal composition since the necessary colloidal material is missing. A sugar solution of 10 per cent leads to the formation of gel only, and thin sections show very little crystallization under the microscope. The solubility of SiO_2, Al_2O_3, Fe_2O^c, CaO, calciumsilicates and calciumaluminates, in sugar solution is greater than in water which fact lessens the tendency to crystallize. On the other side, sugar promotes the formation of gels. Several microphotographs are given.—A. E. BEITLICH

Multistage process for burning portland cement clinker. ROBERT D. PIKE. *Ind. & Eng. Chem.*, Feb. 1930, V. 22, No. 2, p. 148-152.—Large scale experiments in multistage burning conducted by author have indicated large savings in fuel consumption and have furnished information for rational design of a three stage process. Experiments at the Davenport plant of the Santa Cruz Portland Cement Co. gave evidence that the process would result in a decrease of about one half in fuel consumption. The prepared raw material was fed to a multiple hearth calciner of a modified Herreshoff type fired with injected fuel over the bottom of the hearth. The hot calcines passed directly to the rotary kiln and the hot combustion gases from the rotary entered the calciner at a little above mid-height. Hot clinker from the rotary dropped into a regenerative cooler which in turn furnished hot secondary air for combustion of fuel in both the rotary kiln and the calciner. Three modifications of this process are suggested. (1) Instead of using injected fuel in the calciner it may be replaced in whole or in part by broken solid fuel mixed with the material in the calciner. (2) Two calciners may feed the hot calcines to one rotary. (3) The gas of combustion from the rotary, instead of passing into the calciner, may go directly to a waste-heat boiler. Computed heat balances for several arrangements are given for comparison. The outstanding characteristics are as follows: (1) One calciner in series with one rotary. Rotary gas to calciner. B. T. U. per bbl. of clinker 772,000. Potash recovery could not be accomplished as advantageously as in (2), (3) and (4). (2) Two calciners in parallel, each in series with one rotary. Rotary gas to calciner. B. T. U. per bbl. of clinker, 703,000. (3) Same as (2) except rotary gas to waste-heat boiler. B. T. U. per bbl. of clinker, 685,000. (4) Crushed limestone first completely calcined in modified Herreshoff, then mixed with clay, ground and burned to clinker in the rotary. B. T. U. per bbl. of clinker, 1,021,000. Possible saving of half cost of raw grinding. Rotary gas temperature too low for profitable steam generation. Arrangement (4) is in principle the same as that used in Japan by the Asano Portland Cement Co. at the Hokkaido plant. A report of this operation indicated a threefold increase in output and a saving of one half the power for raw grinding. The collection of potash in connection with some of the above arrangements is discussed in considerable detail.—ROY N. YOUNG

Feeding cement slurry into the rotary kiln. ERICH SCHIRM. *Tonind. Ztg.* (Germany), 1930, V. 54, p. 8-11.—A description of several methods including German pats. 425,846, 421,551, 478,632, 436,700, and British pat. 284,-276 and U. S. pat. 1,640,528. These include various spray devices and means for preventing the drying mud from sticking to the kiln.—F. O. ANDEREGG

Durability of portland cement. THADDEUS MERRIMAN. *Eng. News Record*, Jan. 9, 1930, V. 104, No. 2, p. 62-64.—The author makes use of the sugar solubility test formerly described by him (cf. *Eng. News Record*, 1924, V. 93, p. 669) and again referred to in *J. Am. Concrete Inst.*, 1929, V. 1, p. 95, but introduces an altogether different method of using that test. Instead of attempting an evaluation of the cements on the basis of their solubility in his sugar solution under the conditions of test, he notes the *difference* in titratable alkalinity of each solution when the titration is made with two different indicators: phenolphthalein and methyl orange. The author then compares these differences, which will be referred to as Merriman's index, with the condition of seven day neat briquettes after storage for periods of two and five months in a solution of 10 per cent sodium sulfate. The 32 cements of Committee C-1 were used. A marked concordance is observed and the author concludes that this "is so striking as to leave practically no room for doubt as to the value of this indication as a measure of cement durability." Relationship occurs between index values and the Al_2O_3 content of the original cements. Accordingly, he suggests a limiting upper value for the index of 5.8 and for the alumina of 5.70. (From Portland Cement Ass'n Literature Supplement.)

Modern cement transportation. A. GLOZ. *Tonind. Ztg.* (Germany),

1930, V. 54, p. 112-113.—A description of the transportation of bulk cement, a Fuller-Kinyon system or drag being used for loading and unloading.—F. O. ANDEREGG

Gypsum and phosphate-gypsum as retarding agents. A. DAHLGREEN. *Zement* (Germany), Jan. 1930, V. 19, No. 2, p. 28-9.—Portland cement clinker was ground to different fineness with additions of gypsum and phosphate-gypsum ranging from 1 to 5 per cent. The composition of gypsum was 92.5 per cent $CaSO_4 + 2H_2O$ and 1.87 per cent $CaSO_4$, the composition of the phosphate-gypsum was 85.64 per cent $CaSO_4 + 2H_2O$, 7.80 per cent $CaSO_4$ and 2.3 per cent P_2O_5. The phosphate-gypsum has a greater retarding influence, especially with 0.5 to 1 per cent, than the gypsum. Furthermore it lowers the 3-day tensile strength. The 7- and 28-day strengths are about the same with both materials.—A. E. BEITLICH

Internationalization of standards, 3-4. C. R. PLATZMANN. *Zement* (Germany), Jan. 1930, V. 19, No. 1-2, p. 4-7, 49-52.—The author favors the efforts to a uniformity of all European standard specifications for testing cementing materials. The advantages and disadvantages of the different specifications are described. Special consideration is given to the high alumina cements.—A. E. BEITLICH

The influence of the particle size of cement. OTTO GRAF. *Zement* (Germany), Jan. 1930, V. 19, No. 2, p. 48-9.—Experiments were carried out in order to determine the influence of the particle size and the W./C.-ratio on the strength properties of portland cement. In cases where cement is used for concrete mixes which are wet enough to pour, special strength tests must be made since the standard tests do not show the value of cement under these conditions.—A. E. BEITLICH

Chemo-dynamic processes in the cement. HEINRICH LUFTSCHITZ. *Zement* (Germany), Dec. 1929, V. 18, No. 51-52, p. 1458-63, 1483-90.—A comprehensive investigation was made in order to study the diffusion and absorption processes in cement and concrete during the time from the mixing with water to the beginning of the setting process. The forces developed and the changes in chemical composition taking place during this period were also taken into consideration. Two kinds of diffusion, both of which can lead to decrease in strength, could be distinguished namely: (1st) escape of chemical ingredients from the hardening cement and (2nd) diffusion of colloidal products from the aggregates into the cement gel. Reduction in strength can amount to 80 per cent. Analysis of concretes made with good clean aggregates do not show the values for cement but mostly values for products which are enriched with Fe_2O_3 and Al_2O_3. Three portland cements, two high early strength cements, one blast furnace slag cement, one high alumina cement and one iron-portland cement were mixed with water to normal consistency. The first series was placed in a beaker under water immediately after mixing, a second series after beginning of the setting process. Similar tests were made with these samples in distilled water. From the first series, the blast furnace slag cement disintegrated at once in ordinary water, and one of portland cements with 67 per cent CaO disintegrated in distilled water. All the samples from the first series sometimes showed a heavy white coating on the surface, while the samples which were placed under water after the setting process had started remained dark. In order to study the tensile strength of these cements test-pieces were made and placed under water as with the above mentioned samples. Only the testpieces from the alumina cement kept their form when placed at once under water. The two high early strength cements disintegrated also after the beginning of the setting process. All the samples showed a remarkable reduction in strength compared with the normally tested samples. Special care was given to the analysis of these cements and the amounts of salts were determined which escaped by diffusion from the cements. Amounts ranged from 1 to 4 per cent in the case of the samples which were placed under water immediately after mixing and from ¼ to 2 per cent for those immersed after the start of the setting process. One of these cements was also

tested for its variations in compressive strength. The second question was to investigate the interior forces during the hardening process. Small rubber balls, which were filled with ink and provided with a long capillary tube at the top, suited this purpose. Each one was surrounded by the cement-water mixture and the behavior of interior forces during setting and hardening process could be observed from the rise and fall of ink column in the capillary tube. Temperature was kept constant at 14° C. for 28 days and readings were taken every ¼ hour at first, then every hour and later every three hours. The internal heat, due to the chemical reactions in the mixture could be neglected. The curves show a sharp drop during the first 3 or 4 hours, the ink disappearing in the rubber ball. After this the liquid rose again and reached the highest point after about 7 hours, then a slow decrease took place. Photographs of the different specimens are reproduced and results of the tests with the rubber balls are shown in graphs.—A. E. BEITLICH

A. S. T. M. established laboratory equipment tolerances. *Concrete* (*M. S.*), Dec. 1929, V. 35, No. 6, p. 119—Proposed apparatus tolerances for cement testing inspection prepared by American Society for Testing Materials and Bureau of Standards.—(From Portland Cement Ass'n. Literature Supplement).

Density of calcium hydroxide and the role of that material in the shrinkage of portland cement. P. JOYE AND P. DEMONT. *J. Chim. Phys.* (France), 1929, V. 26, p. 317-18.—The authors discuss the densities of calcium hydroxide and calcium carbonate and conclude that calcium hydroxide plays a part in the diminution of volume of portland cement.—(From Portland Cement Ass'n. Literature Supplement.)

Method of studying reactions in a portland cement kiln. W. N. LACEY AND HUBERT WOODS. *Rock Products*, Jan. 18, 1930, V. 33, No. 2, p. 54-55.—Samples were taken at different lengths along a 100-ft. rotary kiln over a period of hours, while the kiln was under operation. Analysis of a typical set of samples composited from five consecutive hourly samples, indicate that comparatively little calcination of limestone occurs in the upper 45 ft. of this kiln's length. During passage of the next 25 ft. calcination occurs rapidly. After this stage recombination of the lime has become rapid, lowering the free lime, although calcination continues to take place. Details of the sample tubes installed in the kiln and sample cup are given. Two illustrations and three diagrams.—J. J. LANDY

Shells and clay are raw materials used at Trinity cement plant in Houston. T. K. KNOX. *Pit and Quarry*, Jan. 1, 1930, V. 19, No. 7, p. 26-36. This plant is within the city and on the ship canal on which the raw materials are transported—the clay from a deposit about 19 mi. down the channel, the oyster shells from reefs in Galveston Bay about 55 mi. distant. After washing the shells analyze: $CaCO_3$, 98.2 per cent; Al_2O_3, 0.6 per cent; SiO_2, 1.0 per cent. A crane with crawler treads unloads shells and clay from barges. The clay goes through a wash-mill on the dock and is rendered sufficiently fluid for pumping. Shells are unloaded to storage whence they are recovered by an electric traveling crane with clamshell bucket and delivered to the two raw grinders. Gypsum is unloaded from freight cars into a chute, elevated to a storage silo, and thence by traveling crane to the finish grinder. Mud is pumped to the clay-storage tanks in which proper blending is done by paddle agitators accompanied by transfer from tank by pumps. Raw and finish grinders are alike, each being a 3-compartment tube mill 8 ft. in diam. and 40 ft. long. Slurry is kept comparatively low in water content. It runs from the mill to a screw conveyor which carries it to centrifugal pumps which, in turn, deliver it to the slurry-storage tanks. Twelve tanks are used for agitation and correction of slurry and two for kiln feed. A Ferris-wheel type feeder delivers slurry to gas fired kiln which is erected high from the ground. It is 300 ft. long, 11 ft. in diam., with four tires. Combustion air is preheated by passing over hot clinker. Clinker drops from kiln to rotary cooler and after cooling is con-

veyed and elevated to clinker storage. Finished product, 92 per cent of which passes a 200-mesh screen, is handled from the discharge pit by pneumatic pump to the eight storage and packing-house silos more than 200 ft. distant and 100 ft. higher. Storage silos, 80 ft. high and 33 ft. in diam. are set upon concrete columns above the packers. The plant has a complete dust-collecting system. Twenty-three illustrations.—A. J. HOSKIN

Cement Technology in 1929. C. H. SONNTAG. *Pit and Quarry*, Jan. 1, 1930, v. 19, No. 7, p. 37-38—A review of salient features in the cement industry, covering stripping, quarrying, raw grinding, slurry filtration, burning, waste-heat boilers, powdered-coal preparation, clinker cooling and storage, clinker grinding, packing and shipping, dust collection, anhydrite vs. gypsum, and water transportation.—A. J. HOSKIN

Trinity's cement plants at Dallas and Fort Worth each has capacity of 4,000 barrels daily. T. K. KNOX. *Pit and Quarry*, Jan. 15, 1930, v. 19, No. 8, p. 27-39.—Fort Worth plant has wet process, the Dallas has dry process. Remotely-controlled electric haulage system is employed in Fort Worth quarry, cars being loaded by power shovels. One large hammermill, the only crusher in plant, crushes shale and limestone. Two combination mills do the raw grinding, the slurry being conveyed by centrifugal pumps to six mechanically agitated mixing tanks. From mixing tanks, slurry is pumped to six correction tanks, and finally to two feed tanks where it is again mechanically agitated. Both kilns, 250 ft. long, are in the open except at ends. Fuel is natural gas. Coolers are 50 ft. long, directly beneath kilns. Clinker may drop to a tunnel below instead of to the coolers. Clinker from coolers is elevated to clinker storage. Cement from finish grinders passes to an elevator, to a hopper, through a feeder, to belt conveyor, to packing house, over a weightometer, to cross-conveyors, to bins for stationary packers or to six silos for portable packers. Portable packers are on a truck with a trailer carrying sack conveyor. At Dallas plant, shale and lime-rock which lie contiguous in the quarry, are handled in separate plants, before mixing. Loading is by power shovels. Primary breaker is a roll crusher. Crushed stone goes by pan conveyor to hammermill for secondary crushing, and then by belt conveyor to rock storage. It is withdrawn to be delivered to gas-fired dryers or redistributed in storage. After drying, material is screw-conveyed to a bucket elevator and fed to six ball mills for preliminary grinding, after which it is conveyed to bins where it is automatically sampled for analysis. It then is fed to a screw conveyor, to a bucket elevator, to bins above scales. Raw shale is crushed in a remodeled dry-pan mill, dried in gas-fired dryer and conveyed to shale storage, whence it is removed by tunnel conveyor to vertical elevator, to scale hopper. Stock-charging scales weigh both kinds of material simultaneously and dump into the hopper of mixer. Mixture is passed through tube mills, screw-conveyed to the kiln-feed tanks, sampled and fed to five gas-fired kilns. Clinker falls into a water-cooled conveyor which takes it to storage. It is removed from storage to rotary cooler, although partially cooled, thence to six first-stage grinders. Final grinding is in tube mills. Forty-eight illustrations.—A. J. HOSKIN

Portland cement industry in 1929. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 84-93.—A critical review of the industry with significant data on production and shipments by districts for 1929. A comprehensive tabulation of developments at existing cement mills, projected plants, etc., is given. Properties of present-day cements are discussed and future trends of cement research are included. Eight illustrations.—J. J. LANDY

Natural Cements in 1929. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 93.—Review of industry for 1929 indicates wide interest in possibility of natural cement as special mason's cement and stucco.—J. J. LANDY

Progress in research and technology of rock products in 1929. *Rock Products*, Jan. 18, 1930, V. 33, No. 2, p. 47-53.—Summary of abstracts and scientific papers published during 1929, on subjects including cement and cement manufacture and testing, limes, gypsum, concrete and aggregates.—J. J. LANDY

Cement mills establish safety record. *Rock Products*, Jan. 18, 1930, V. 33, No. 2, p. 71.—Twenty-six mills win Portland Cement Association safety trophy award in 1929.—J. J. LANDY

What the American Concrete Institute has done and is doing. HARVEY WHIPPLE. *Rock Products*, Jan. 18, 1930, V. 33, No. 2, p. 79-80.—A brief summary of important investigations bearing on the rock products industry, including of cements, aggregates and admixtures and ready mixed concrete.—J. J. LANDY

The effect of fluorspar on the cement kiln lining. ALFRED MULLER. *Tonind, Ztg.* (Germany), 1929, V. 53, p. 1481-83.—The analysis of the finished cement repeatedly failing to check that calculated from the analysis of the raw materials for Al_2O_3 and Fe_2O_3 led to the discovery of an attack on the lining of the kiln. CaF_2 had been added to the raw materials and formed low-melting compounds with the alkalies present, which then soaked into the refractories lining the kiln. There AlF_3 and FeF_3 were formed and as both of these boil below 1000° they were boiled off, to be condensed later upon the incoming feed. The result was replacement of sesquioxides in the lining by alkalies. This was confirmed by placing CaF_2 with alkalies in contact with refractories at 1450°. A considerable attack was observed.—(From Portland Cement Ass'n Literature Supplement.)

Bureau of mines work on nonmetallics during 1929. OLIVER BOWLES. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 142-143.—Economic and technologic studies reviewed.—J. J. LANDY

MISCELLANEOUS.

Water glass as a protective coating for concrete and stones. C. R. PLATZMANN. *Tonind. Ztg.* (Germany), 1930, V. 54, p. 73-75.—Water glass may have some protective action as applied to concrete after pouring. It should not be added to the mixing water, even to accelerate the hardening, as its harmful effects including efflorescent action are greater than the benefits. If a stone is very porous its efficacy as a protective coating is doubtful.—F. O. ANDEREGG

Method for capping concrete cores and cylinders. P. J. FREEMAN. *Nat. Sand Gravel Bul.*, Jan. 1930, V. 11, No. 1, p. 5-6.—A method of capping concrete cores and cylinders has been developed by the Bureau of Tests and Specifications, Department of Public Works, Allegheny County, Pittsburgh, Pa., which, from evidence available, develops the true strength of concrete. Material used for capping consists of sulphur and some material such as fireclay or limestone dust combined in about equal amounts, depending on the specific gravity and voids of the filler. This compound may be made in any laboratory but care must be exercised to use dry and properly proportioned materials. The most satisfactory method for capping cores or cylinders is to place them in a horizontal position and to pour the heated compound into an apparatus designed for that purpose. The compound should not be heated above its first melting point, as it will thicken with increased temperature. Crushing strength of properly prepared capping material is at least 8,000 lb. per sq. in. when tested as a 2 by 4-in. cylinder. A flat specimen 6 in. in diameter and one or two inches thick has a crushing strength of more than 200,000 lbs. The hot material will adhere to the specimen whether it be wet or dry, and cools quickly so that specimens may be tested within a few minutes after reaching the laboratory. The results obtained are said to be better than by any system of capping with other materials.—STANTON WALKER

PROPERTIES OF CONCRETE

Alternate hardening of cements. JOSEPH KEITH. *Tonind. Ztg.* (Germany), 1930, V. 54, p. 27-29.—After a period of combined storage of 1 day damp, 6 days wet, and in air for 7, 14 or 21 days, the specimens lost compressive strength at first on being placed in water. This was usually regained on further storage in water. Sometimes, however, the strengths especially tensile strengths apparently continued to fall during storage in water.—F. O. ANDEREGG

A device for the automatic regulation of the temperature in storage tanks for testpieces. A. GUTTMANN. *Zement* (Germany), Jan. 1930, V. 19, No. 2, p. 24-5.—The tanks are provided with four 125 watt immersion heating units and a mercury thermoregulator. The latter operates the heating units and a stirring motor when the temperature drops below the regulating point. The temperature can be kept constant with an accuracy of 0.1-0.2° C. The power consumption is very low and amounts to 1.1-1.3 kw. to keep 150 liter water at 19° C. for 24 hours.—A. E. BEITLICH

Thermal expansion of cements and their mixtures. SHICHIRO UCHIDA. *Memoirs of Sendai Higher Tech. Sch.* (Japan), V. 7, No. 1, p. 1-93.—Determination of thermal coefficient of expansion for cement, mortar, and concrete has been made by several authorities, but in most cases it has been measured after moisture contained in the specimen had been expelled by prolonged heating at a high temperature. After such treatment, the heating curve usually coincides with the cooling curve. In considering the question of fire resistance, it is important that the measurement should be made for the first heating of the material. The purpose of the investigation was to study the expansion of cement and its mixtures under different conditions from the first heating. Each test specimen was made in the form of a cylinder 5 mm. in diameter and 3 cm. long. These were first placed in a moist box for 24 hours and then stored in water. In testing the specimen was placed on the inside of a silica tube which extended into an electric furnace. Another small silica tube which pressed against one end of the specimen served to transmit the expansion or contraction to a rotating mirror. The magnitude of the rotation was measured with a scale and telescope. The measured changes were corrected for the change in length of the silica tube. The temperature of the specimen was measured by means of a thermocouple. The conclusions resulting from the tests are as follows: (1) The expansion coefficients of the cements with or without admixtures increases considerably with the rise of temperature. (2) The coefficient for neat cement varies according to the chemical composition. (3) No admixture has any considerable effect on the thermal expansion of cement. (4) The relative richness of a cement and sand mixture has practically no effect on the expansion coefficient for temperatures ranging from 50° to 100°. (5) There is practically no difference between the expansion coefficient of steel and that of portland cement, so that no special considerations need be given to the relative coefficients of expansion of steel and cement with or without admixtures in structures subjected to ordinary temperatures. A considerable difference exists at high temperatures, 400°-500°. (6) The expansion coefficient of aluminous cements is smaller than that of portland cements; hence if these cements are used together in a structure of reinforced concrete, a high thermal stress will be caused between them since the coefficient for these materials differs greatly for all temperatures.—D. E. LARSON

The increase of strength of concrete, mortar and cement with age. SHICHIRO UCHIDA. *Memoirs Sendai Higher Tech. Sch.* (Japan), Dec. 1929, V. 8, No. 1, p. 1-23.—Tests were made of neat cement, mortar and concrete, using 4 x 8-in. and 6 x 12-in. cylinders and prisms about 2.8 by 2.8 by 4.2 inches. Five brands of cement, passing the Japanese Government specifications, and Tama river sand and gravel were used. All specimens were stored

in fresh water, at about 61° F., until tested. Generally 5 specimens of a kind were tested at ages of 1, 2, 3, 5, 7, 15, and 28 days. For the concrete specimens the age was extended to 60 days. The tests include (a) compressive strength of neat cement, one brand, 4 consistencies, (b) tensile and compressive strength of 1:3 mortar, one consistency, 5 brands of cement, and (c) compressive strength of concretes, one consistency and brand of cement, 4 mixtures. Constants in an empirical formula in which the strength is given as an exponential function of the age are determined for all of the age-strength data secured. The correctness of these formulas has not been verified beyond the age of 60 days.—F. E. RICHART

Effect of temperature on cement. A. C. BLACKHALL. *Concrete* (*M. S.*), Dec. 1929, V. 35, No. 6, p. 110.—Low temperatures tend to retard setting and hardening to an extent that varies with the cement and thus may deprive the rapid hardening variety of that special advantage. Hence before inference is drawn regarding a particular cement it should be tested under conditions of temperatures similar to those which are likely to be used in practice. — (From Portland Cement Ass'n. Literature Supplement.)

Studies on cement mortars and concrete. Effect of common salt on the tensile strength of cement mortars. A. GORDEN AND I. SONZA. *Philippine Agr.* (Philippine Islands), 1929, V. 18, p. 13-18.—An analysis of Philippine portland cement is given. Admixtures of NaCl up to about 11 per cent with a maximum at 8 per cent increases the tensile strength of cement mortars in 7 and 28 days. The strength ratios for 7 day are greater than 28 day tests, with mixtures containing 8-10 per cent NaCl. The mean tensile strength of cement mortar with NaCl admixtures greater than 8 per cent decreases more abruptly in 7 day than in 28 day tests. The differences in strength are decidedly significant. — (From Portland Cement Ass'n. Literature Supplement.)

Small causes, great effects. B. WINKLER. *Tonind. Ztg.* (Germany), 1929, V. 53, p. 731-32.—Brief descriptions are given of two failures of rapid-hardening portland cement concrete. In the one case, failure was traced to contamination of the sand with clay. In the other, it was found that the brand of cement had been changed, but that no alteration had been made in the water-cement ratio selected at the beginning of the job. Subsequent examination showed that the second brand should have been used with a smaller water-cement ratio. — (From Portland Cement Ass'n Literature Supplement.)

Tests concerning the changes in length and structure of concrete aggregates under the influence of temperatures up to 1200° C. "Versuche ueber Laengenund Gefuegeanderungen von Betonzuschlagsstoffen unter der Einwirkung von Temperaturen bis 1200° C." DR. KURD ENDELL. (Germany), 1929, Wilhelm Ernst and Son. Reviewed in *Zement* (Germany), Jan. 1930, V. 19, No. 2, p. 40.—The book shows the behaviour of construction materials in fires. The report is presented of an investigation carried out on behalf of the German Reinforced Concrete Committee in the Laboratory of the School of Building Science Technology of the Technische Hochschule, Berlin. Specimens of eleven different natural stones, one blast furnace slag, one Mansfield copper slag, one type of broken brick, and neat portland cement and, further, specimens of 1:3 mortars of the cement and the above-mentioned aggregates were heated in an electric furnace to 1200° C. Neat cement and mortar specimens were heated after 28 or 50 days in combined storage. The temporary changes in length were observed at various temperatures up to 1200° C. and are shown graphically. The apparatus used is described in detail. After cooling, the structural alterations suffered by the specimens were examined microscopically and macroscopically. Neat portland cement exhibits a small expansion up to about 300° C., above this temperature contraction occurs as a result of the expulsion of chemically and physically bound water. After heating to 1200° C., the calcium hydro-silicates and calcium hydro-aluminates appear to have partially

decomposed and liberated lime. A sound portland cement heated to 1200° C., will therefore become unsound on cooling and after a few weeks will be liable to disintegrate. Portland cement mortars (1:3) display the characteristic movements of the aggregate toned down by the shrinkage of the cement. A bibliography is included.—(From Portland Cement Ass'n. Literature Supplement.)

Research activities of Portland Cement Association for 1929. F. R. McMILLAN. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 148-149.—Behavior of concrete under different conditions of exposure studied. Results indicate: (1) Of all the destructive agencies which attack concrete, repeated freezing and thawing of absorbed moisture is by far the most severe. This shows the necessity for producing concrete that resists the penetration of water in those localities where repeated freezings must be encountered. (2) Most of the defective concrete occurs in patches, as at honeycombed spots or laitance seams, while the intervening portions of the structures are in well preserved condition. This indicates the extreme importance of proper proportions, consistency and care in placing. Where the defects are due to improper materials, their distribution is more general over the exposed surface of the structure. The examples of this latter condition are much less numerous than those due to improper manipulation. Aggregates were studied to establish whether any of the common rock types are undesirable as aggregates and to develop tests that will disclose the presence of non-durable minerals. Other studies include: (1) A survey of concrete highways in which a detailed study of thousands of miles of pavement is being made to correlate the present condition of pavement with records of materials and methods used and with the weather conditions attending construction and the climatic and traffic conditions since being placed in use. The survey is now complete for the territory east of the Mississippi river. This is to show direct and immediate ways to improve practice. (2) Effects of moisture and frost. The results to date in these tests have shown that both the water-tightness of concrete and its resistance to repeated freezing are determined by the same factors which are known to govern the other desirable properties of concrete—strength, resistance to wear and bond resistance. Any reduction in the water-cement ratio, provided the aggregate proportions are adjusted to maintain plasticity necessary for proper placing, will be accompanied by increased water-tightness and greater resistance to freezing. Any additional curing in the early period is shown to result in a marked improvement in water-tightness. Indications are that resistance to repeated freezing is likewise greatly improved by longer curing before exposure. (3) Study of volume changes in concrete due to the loss or absorption of moisture. Work gives promise of bringing out a definite relationship from which it is hoped actual volume changes may be predicted for given mixtures and conditions of curing. (4) Surface coatings for curing concrete. Study brings out that the effectiveness of any surface coating as a curing agent is measured by extent to which it is able to keep within the mass the original mixing water. (5) Fire resistance of concrete units. (6) Admixtures and studies of constitution and properties of cement. —J. J. LANDY.

Japanese research on cements and concretes. *Rock Products*, Jan. 18, 1930, V. 33, No. 2, p. 56-59.—Abstracts given are: Microscopic hydration of rapid hardening cements; studies on modulus of rupture of cement mortar; tests on the fused portland cement and aluminous cement; acid-proof cement mortars; strength formula of cement-mortars; electrical investigation of the setting and hardening of rapid-hardening cements; quality of portland cement of Japan; relations between composition and strength of cement mortar on combined hardening; recent advances in Japanese portland cement industry; studies on laitance of cement mortars and concrete; electrical method of measuring the setting time of portland cement; studies on mixed portland cements; calcium aluminates and their hydration; mixed portland cements (neo-solidits); acid-proof cement mortars.—J. J. LANDY

Revisions needed in gunite specifications. JOHN V. SCHAEFER. *Eng. News-Record.* Jan. 16, 1930, V. 104 No. 3, p. 108.—Present standard specifications for gunite calling for three parts sand to one of cement have proved to be correct in theory only. Dry sand referred to in specification may contain 4 to 8 per cent moisture, the average bulking being about 33 per cent. Rebound of sand when gun is used still further reduces sand in mortar, making final proportions 1.68 to 1 instead of theoretical 3 to 1. Suggested specifications for cement gun work include provision that portland cement be mixed with clean sharp sand in a proportion that will be as nearly practical 1 of cement and 3 of dry sand. The proportion of sand shall be varied from time to time as the bulk of sand exceeds the bulk of dry sand due to moisture content. Sand and cement shall be thoroughly mixed dry and screened through a ⅜ in. mesh screen before being placed.—D. F. JENNINGS

The behavior of a reinforced concrete arch during construction. SEARCY B. SLACK. *Proc. Am. Soc. Civil Eng.*, Nov. 1929, V. 55, No. 9, p. 2279-2305.—Heretofore tests on arches have started with a completed structure or model that had already taken unknown initial strains due to dead load, temperature changes and the chemical action of setting. The Yadkin (cf. *Proc. Am. Soc. Civil Eng.*, March 1929, p. 608) river bridge test studied live load effects while W. M. Wilson (cf. *Proc. Am. Soc. Civil Eng.*, March 1929, p. 712) has contributed to the knowledge of climatic effects. The present paper attempts to round out the subject by supplying data from the starting of arch rib concreting to about one month after completion, a period of four months. It includes measurements of strain in steel and concrete beginning with zero strain while concrete was being placed. Compressive strength, modulus of rupture, and modulus of elasticity of arch rib concrete were determined from control specimens for various ages. Temperatures were taken and movements of crown, abutments, expansion joints and decks were measured. The bridge, in Putnam County near Eatonton, Ga., is an open spandrel arch type span of 160 ft. and 46 ft. rise with concrete girder approach spans at each end.

Electric telemeters and resistance coil thermometers were used for strain and internal temperature measurements. Observations started 24 hours after the concrete was placed and readings were taken twice daily. Efforts were made to co-ordinate the observations on the arch with those on unloaded moderately reinforced test blocks 25 by 25 by 60 in. (1) The arch ribs began rising and falling from atmospheric causes between three and four days after pouring. (2) Due to set of concrete while initial temperature is high, no design allowance need be made for rise in temperature. Falling temperature should be considered. (3) There was no measurable movement of the abutments. (4) Observed stresses in steel and concrete were consistently higher than computed stresses. (5) There are appreciable initial stresses in both steel and concrete probably due to the setting of the concrete. (6) The concrete temperature increased rapidly for 12 to 36 hours after pouring then fell gradually to mean atmospheric after 10 to 12 days. (Abstractors comment—Fig. 13 of the paper shows a rising temperature during about a week.) Variation then follows mean atmospheric temperature. Daily variations are slight and changes are slow.—H. J. GILKEY

Control of materials and mixtures for concrete for pavements.* R. W. CRUM.—Methods used by the Iowa Highway Commission in controlling the quality of concrete for pavements are described. Present specifications are discussed and it is shown that the method of specifying proportions by weight with definite limiting water-cement ratios and cement factors provides concrete of definite quality and constant yield. Six different proportions are given in order to utilize local materials most economically. The various field operations connected with control are described in detail as well

*Presented before the 9th annual meeting of the Highway Research Board, Washington, D. C., December 13, 1929. Abstracted in advance of publication.

as methods for making field determinations of specific gravity, moisture, etc. Specifications for weighing devices as well as methods of inspecting weighing devices are given. Approved methods of measuring water are also given and it is shown that use of an auxiliary storage tank on top of mixer, from which measuring tank may be filled, will result in much more accurate control in that the effects of fluctuations in pipe line pressure are thus eliminated. In order to determine the proper time for opening pavements to traffic, a series of concrete beams are made in conjunction with each job. These beams are broken at the age of 4 and 10 days in a transverse testing machine designed for the purpose. This device is described in detail. Results of control tests which have accumulated during the past eight years are analyzed in considerable detail and indicate that uniformity of quality of concrete has materially improved during this period. In period 1921, 1922 and 1923, only 36 per cent of the 28 projects constructed showed a mean variation in strength of 10 per cent or less from average of all jobs. On the other hand, in 1928, 68 per cent of 69 jobs showed a mean variation of 10 per cent or less from the average. This would indicate a marked improvement in uniformity during the period, due undoubtedly to the introduction of more scientific and improved methods of control throughout this period. The relation between strength of concrete as indicated by cores drilled from the pavement as compared to molded cylinders is also discussed and it is shown that average molded cylinder strength at 28 days is somewhat higher than indicated core strength at the same age; also that core strength at age of approximately 6 months is roughly 30 per cent higher than corresponding value at 28 days. Effect of type of coarse aggregate on strength is discussed and it is pointed out that the average strength of all gravel concrete jobs is practically identical with the average strength of all limestone concrete jobs, although individual projects show quite a range in strength due probably to other factors. The author's general conclusions are as follows: Pavements built under these methods of control cost no more than under the old system. In fact it is believed that the definiteness of the quantities of materials required by the specifications has been a factor in lowering costs. Cost of inspection has not been increased although higher grade inspectors are needed than formerly. Concrete is of high quality and of more uniform character than formerly.

It is therefore reasonable to conclude that the results of the methods of control of the quality of concrete described are more than commensurate with the efforts expended.—F. H. JACKSON

Influence of the leaching of test pieces during water storage. (See MATERIALS *Aggregates*.)

ENGINEERING DESIGN

BRIDGES

The three-hinged arch bridge over the river Marne at Neuilly-sur-Marne. *Zement* (Germany), Jan. 1930, V. 19, No. 1, p. 13-5.—Description of a new concrete railway bridge. Clear span of the arch is 222 ft. and approach viaduct on the right bank of the river is 733 ft. long. The distance between the hinges is 230 ft. and the rise is 24 ft. 3 in. Each half of the arch consists of two slabs connected by ribs. The bridge is provided with a cantilevered footpath on the downstream side. The abutments are founded on caissons.—A. E. BEITLICH

Development tests on a light floor for bridges. LEON S. MOISSEIF. *Eng. News Record*, Jan. 9, 1930, V. 104, No. 2, p. 71-74.—Weight of a modern reinforced concrete slab roadway is a serious factor in the design of a bridge because the amount of material required in the bridge is a function of the load it must carry. The lightest floor slab in use at the present time weighs about 85 lb. per sq. ft. not including the surfacing which weighs about 30 lb. per sq. ft. This article describes the tests of slabs weighing only 57 lb. per sq. ft. The reinforcement consists of small T-irons laid adjacent to each other to form a continuous surface on the bottom.

These T's are transversely connected by bars mechanically pressed together, forming on the top a steel grating with rectangular openings. This steel structure is filled with concrete flush to the top of the openings thus forming a unit slab of steel cells filled with concrete. No formwork is required. The first slab was made of 3 x 3 x $\frac{5}{16}$ in. T's of structural steel. The webs were locked with $\frac{3}{16}$ x $\frac{3}{4}$ in. crossbars spaced 4 in. The purpose of the test was to study the deflections of the slab when acting as a simple beam. The slab had a width of 6 ft. and a span of 3 ft. 10 in., the end supports being 12-in. I-beams. A concentrated load was applied to the center of the slab through a 6 x 16-in. wood bearing block. Failure of the bond between concrete and steel was indicated at a load of 40,000 lb. The yield point of the two middle T's was reached at a load of 55,000 lb. and cracks appeared in the surface of the concrete at a load of 68,300 lb. The maximum load was 71,520 lb. The second slab was tested to study the behavior of a slab continuous over several steel beams, themselves elastic. The slab was placed on three 12-in. I-beams on 4 ft. centers forming two equal spans of 4 ft. each. The slab had a width of 4 ft. The load was applied simultaneously at the center of each span through the wood bearing blocks. Failure of the bond between concrete and steel was indicated at a total load of 80,000 lb., 40,000 lb. on each span. The total ultimate load was 160,000 lb. Standard test cylinders developed an average 28-day compressive strength of 3,220 lb. per sq. in. The slabs were tested at 28 days. The loadings used were chosen because they cover the range of wheel loads specified by bridge engineers for first class highway bridges. The use of additional surfacing to resist wear is not necessary for an armored slab of this type. Thus the total weight saved is about 60 lb. per sq. ft. The original article gives complete data relative to the deflections of the slab for various points and loads. Eight figures.—D. E. LARSON

Pier construction for the S. P. railroad bridge across Suisum Bay. (See FIELD CONSTRUCTION—*Bridges*.)

Remarkable concrete arch at Brest, France. *Eng. and Contracting*, Dec., 1929, V. 12, No. 12, p. 521-522. (cf. "The 600-Ft. Concrete Arch Bridge at Brest, France, by E. Freyssinet and translated by S. C. HOLLISTER, *Proceedings* A. C. I., 1929, V. 25, p. 83-97.) Bridge site is at the entrance to the harbor where the river is more than 2000 ft. wide. Usual difficulties of construction were increased by the rise and fall of the tide. Design consists of short reinforced-concrete approach viaducts and three reinforced concrete arches having 612 ft. spans, c-c of piers, or 590 ft. clear spans, the arches being the longest that have yet been built in concrete. Bridge carries a single track railway and also a 26 ft. roadway for vehicles on the upper deck. The arch section consists of top and bottom slabs connected by four longitudinal walls. Two river piers, founded on rock, were placed by means of reinforced concrete caisson constructed on shore and floated out. As the first pier was poured, the caisson was lifted by stages and finally removed. It was used for the second pier and left in place. The springings of the arches were built out from the piers and abutments as cantilevers, about 50 ft. in length. Cantilevers at the piers were tied together by bars, while a system of jacks allowed tension to be put into the bars. A combination reinforced concrete and timber arch center, which could be used for all three spans, was built on shore. Each end rested on a reinforced concrete pontoon. A series of timber towers built between pontoons, acted as ordinates to the parabolic curve of the centering, the center tower being over 100 ft. high. The ends of the centering were of reinforced concrete, the remainder of timber. Distance between extrados and intrados sections of the centering was about 8 feet. They were connected by lattice bracing. Extrados was of 9 x 3-in. timbers on edge, side by side, and nailed together. Two layers of diagonal planking acted as wind bracing. Intrados members were a series of 9 x 3-in. joists nailed together. Intrados joints were bedded in rich concrete mortar for the decreased compressibility afforded. The ends of the centering were connected by wire ropes with hydraulic

jacks attached so as to tighten or slacken them. Upon completion of the centering, the ropes were tightened, towers demolished, pontoons floated, and centering was raised to position and slung to the projecting cantilever members. The concrete ends of the centering were concreted into shelves left on the undersides of the cantilevers, the piers thus taking the thrust of the arch. The pontoons were removed and pouring of arch ring proceeded. The same center was used to pour the other two arch rings. In niches at the crown of each span, 28 250-ton hydraulic jacks were installed to relieve stresses caused by shrinkage and elastic shortening. The total maximum stress is approximately 1000 pounds per square inch. A strength of 8500 pounds per square inch is expected from the concrete. The proportion of steel reinforcement in the arch is very small. The three arches are complete and it is expected the bridge will be in service within a year. The bridge was designed by E. Freyssinet, who supervised its construction. The contractors are Limousin & Co.—N. H. ROY

BUILDINGS

A guide to the analysis and design of reinforced concrete slabs, beams and tee-beams. *Report Committee of Austrian Concrete Association* (Austria), Aug. 1929, p. 1-49.—*A.* A standard notation for various members of a building structure is used, following that of Austrian Standard B2301, in which the mark of a structural member denotes its classification as well as its location in the building *B.* Bending moment coefficients, are given for beams partly restrained at the ends by masonry or continuity with adjoining members. Coefficients of wl^2 (American notation) are given as 1/10, 1/11, or 1/12 at midspan and 1/20, 1/19 or 1/18 at supports depending upon the end restraint provided. These values are to be disregarded where special analysis of the structure is made. Text book references for the solution of continuous beams are given. Continuous slabs are to be treated as indicated in Austrian Standard B2302. References are given to analyses of continuous beams with varying spans and moving loads. *C.* Formulas are given for the design of singly and doubly reinforced rectangular beams and tee-beams, including the design of shear reinforcement. *D.* Tables for use in design and standard tabular forms for arranging computations are given. A standard practice as to notation and office forms and computation is recommended.—A. A. BRIELMAIER

One-way concrete slab floors widely used in Northwest. GEORGE RUNCIMAN AND H. L. WORTHINGTON, *Eng. News Record*, Jan. 9, 1930, V. 104. No. 2, p. 68-70.—During the past few years, the design of a number of concrete buildings in the Pacific Northwest has been improved and simplified by the use of one-way concrete slab floors. Such floors are suitable for structures of the light load type including apartments, hospitals, hotels, and office buildings. In this type of construction, the slab itself extends the full distance between supports without beams or other stiffening members. The greatest span length is about 20 ft. Disadvantages of one-way slab construction are (1) an increase in the amount of concrete and of steel reinforcing, and (2) increased column and footing loads. The favorable points are (1) a saving in plastering resulting from applying the plaster in one operation directly to the bottom of the slab (2) simplified formwork (3) easy placement of reinforcement and concrete (4) superior quality of concrete and (5) flat ceilings and minimum story height. Because the plaster is applied directly to the bottom of the slab, cracks in the slab will appear through the plastering. Such cracks ordinarily run parallel to the direction of reinforcing. It is, therefore, advisable to use a liberal amount of secondary temperature or shrinkage reinforcement to prevent them. Four figures, one table.—D. E. LARSON

American tests of reinforced concrete beams. OTTO GRAF. *Deutscher Ausschuss fur Eisenbeton* (Germany), 1929, No. 61, p. 1-30.—This publication of the German Committee on Reinforced Concrete was prepared in accordance with a rule of the Committee that plans for new lines of in-

vestigation shall be preceded by a digest of the available literature on the subject. The report reviews American tests on the resistance of various types of shear reinforcement in reinforced concrete beams. Three recent publications are reviewed: Technologic Paper No. 314, U. S. Bureau of Standards, and Bulletins 166 and 175, University of Illinois. The material is translated into German and arranged in German units and notation, largely in the form of tables. The author makes few comments on the tests; in some places he discusses the agreement between American and German tests. The tests of Bulletin 175 are quoted as justifying certain requirements of the present German Standards.—A. A. BRIELMAIER

Efficient concrete plants on two building jobs. ZARA WITKIN. *Eng. News-Record*, Jan. 16, 1930, V. 104, No. 3, p. 112-114.—In building Cedars of Lebanon Hospital containing 10,000 cu. yds. of concrete and Jacob Kalb apartments containing 3,100 cu. yds. of concrete, both in Los Angeles, working drawings of plant were made before jobs were started. Concrete plants were considered in five parts: (1) driveways for aggregates; (2) aggregate and cement storage bunkers; (3) measuring hoppers and mixer; (4) hoist and tower; (5) concrete-conveying apparatus for deposition in forms. Each of these elements is basically affected by height, shape and size of structure. For the 8-story hospital and nurses' home connected by 2-story service building, concrete mixing plant was in front of main building at base of a 200-ft. tower. Concrete for nurses' home was placed by means of cable-supported chute line 225 ft. long set on a 1 to 4 slope from high tower, with auxiliary chutes from end of main chute. Main building was concreted from same tower, using separate chute line on latticed boom with auxiliaries. No carting was required in concreting both buildings simultaneously. For sidewalks and roadways around building, and for floor topping, concrete was discharged vertically from end of chute through wooden box chute with baffle plates to prevent segregation. Plant for concreting apartment building was located below street level in extension of main excavation. Aggregate bunkers were on street level, with measuring hoppers delivering to a funnel which discharged to mixer. Mixer dumped into hoist bucket in tower alongside bunkers. Movable boom chutes reached all parts of building. One man was required for aggregate hoppers and mixer, one for hoistman engineer and two for handling cement and concrete admixture. Six illustrations.—D. F. JENNINGS

DAMS

High rock fill dam designed with jointed concrete face. I. C. STEELE. *Eng. News Record*, Jan. 16, 1930, V. 104, No. 3, p. 92-95.—The Salt Springs dam on the Mokelumne River, California, due to the inaccessibility of the site, is being built of local quarried granite on a solid granite foundation. It is 328 ft. high, 15 ft. wide at top, and is 900 ft. thick at the base. It is of loose rock fill, except the upstream face, which has a placed face of granite 12 ft. to 15 ft. thick and this is to be covered by a reinforced concrete facing varying in thickness from 3 ft. at the base to 1 ft. at the crest. The concrete facing is to be laid in 60 ft. square panels on horizontal and vertical concrete ribs. Construction joints of asphaltic material and copper water stops are provided at edges of all concrete panels to prevent water intrusion and to provide for small movements of slabs. The face is arched upstream in plan with a concave face considering a vertical section parallel to the river. Inequality of settlement of fill was the chief factor in design. An adequate spillway is provided. Six illustrations and one table.—N. H. ROY

Laminated arch dams with forked abutments. FRED A. NOETZLI. *Proc. A. S. C. E.*, Feb. 1930, V. 56, No. 2, p. 261-292.—While no arch dam has failed because of structural inadequacy, there are features in the analysis and action under load that leave much to be desired from the standpoint of definitness, economy and stress distribution. These objectionable features are: (1) Stress computations for a thick arch or cylinder, are highly approximate. (2) The stress intensity varies

widely in different parts of the structure, resulting in much material that is not being used effectively. (3) The stiff cantilever elements assume stress that could be more efficiently carried by the arch elements. For a thin arch the stress distribution is definite and uniform and the cantilever elements are sufficiently flexible to permit normal functioning of the arches. The writer proposes to make major departures in arch dam design that will: (1) Reduce the structure to a series of thin arches with the corresponding advantages noted. (2) Shorten the radius of curvature of the arch rings thereby making the arch elements more effective. The first will be accomplished by dividing the main arch into a series of concentric rings or laminae. One lamina may be kept a little higher than that adjacent to it during construction and a coat of asphaltic paint or other membrane will prevent bond and assure independent movement. The highest lamina will be that upstream and the lowest will be down stream. At different elevations successive laminae will be discontinued as the total thickness of structure becomes less. The shorter radii of curvature are obtained by: (a) Forked gravity abutments of sturdy but economical construction that will shorten the arch span (and therefore permit shorter radii). They will also improve the transfer of load from dam to canyon walls. (b) A distinct downstream slope away from the crown, causing the upstream lamina to actually overhang and the whole structure to resemble a series of conical layers. This gives the more favorable stress distribution offered by the dome type of design without the complicated form work which it requires. In one sense none of the suggested changes is entirely new but the three have never been used together or applied in just the way suggested. The forked gravity abutments were used on the Railroad Canyon Dam, designed by the author, the sloping crown principle appears in different form in the multiple dome dam and the idea of laminations is embodied in a very much different manner in the Dordogne River Dam at Marege, France (now under construction). In this dam the successive laminae of descending height (downstream) are separated by water pools 60 ft. or more in width.—H. J. GILKEY

Hydro power development at Smoky Falls. *Can. Eng.*, Jan. 14, 1930, V. 58, No. 2, p. 121.—The Spruce Falls Power and Paper Co., Ltd., has completed and placed in operation a power development at Smoky Falls on the Mattagami River to supply power to a pulp and paper mill at Kapuskasing, 50 miles distant. The Mattagami River has a maximum run-off at the site of 138,000 cu. ft. per second down to 6000 cu. ft. per second required for operation, regulated by existing conservation laws higher up. Natural head of 74 ft. is increased to 114 ft. due to the natural rocky formation at the dam site. Control dam at Smoky Falls is of concrete with a gravity overflow section, having a length of 1250 ft. and a maximum height of 65 ft. Adjacent to the spillway crest which is 663 ft. long is a stony sluice dam having 10 openings 40 ft. wide controlled by electrically operated steel gates 30 ft. high. The headworks, immediately above the power house, is a concrete gravity dam section with a maximum height of 100 ft. above the river bed and a length of 500 ft. Power units, of which three of the four installed, are vertical shaft turbines with maximum rating of 18,750 H. P. each at 113 ft. head and speed of 163.5 r. p. m. Between Stoney Sluice Dam and headworks dam is an earth dam 1400 ft. long with a maximum height of 25 ft. with a cut-off wall of interlocking steel piling. Quantities of materials involved were 192,000 cu. yd. concrete 3,500,000 lb. reinforcing steel and 9500 tons of structural steel.—G. M. WILLIAMS

Repairs to dam at Lake St. Francis. P. E. BOURBONNAIS. *Can. Eng.*, Jan. 21, 1930, V. 58, No. 3, p. 141.—Allard Dam, to regulate the flow of the St. Francis River at head in Frontenac Co., Quebec, was built in 1916-17. Dam consists of series of concrete arches supported on buttresses which rest upon a hard, homogeneous impervious mixture of clay and pebbles. Length of dam is 602 ft. maximum height 43 ft. Piers are 32 in number,

5 ft. thick. Reinforced concrete slab serves as foundation mattress to support piers and is attached to two core walls each 10 ft. deep at heel and at toe. Upstream face of bulkhead section and that of spillway section are laid at an angle of 55 degrees with horizontal and the downstream face of buttresses placed at an angle of 72 degrees with horizontal. Crown thickness of arch is 3 ft. at bottom under 35 ft. head and 18 in. at top. Intrados curve has radius of 15 ft. Water levels behind dam varied greatly during the year, being drawn down during the winter with temperatures as low as 30° F., which resulted in freezing of saturated concrete. Disintegration due to frost action was progressive and investigation in 1926 showed that deck slabs of the bulkhead section, which were not protected by a down stream slab, were badly damaged. Noses of piers between spillway openings and the bottom sluice bays were also badly disintegrated. Deterioration was attributed to frost action and poor quality of concrete. Repairs were made by chipping away disintegrated concrete, following which the surfaces were sand blasted with wet sand from the nozzle of the cement gun. Wire mesh reinforcement was then attached to the concrete by means of expansion bolts and a 1:3 gunite coating with a minimum thickness of 2 in. was applied. Total area treated was about 50,000 sq. ft.—G. M. WILLIAMS

MISCELLANEOUS STRUCTURES

Concrete troubles and how they should be avoided. G. MCLEAN GIBSON. *Str. Eng.* (England), Jan. 1930, V. 8, No. 1, p. 26-32.—Structural troubles are generally due to inefficient design or insufficient knowledge of design by the constructor as shown by many specific instances of misplaced reinforcing steel and neglect of possible hydraulic pressure. Carelessness in checking design may also lead to unfortunate results. Troubles may develop when proper allowance is not made for the concrete to contract when hardening, and to expand and contract after hardening due to moisture changes. Ordinary concrete may be expected to contract not more than ¼ inch in 100 feet. The use of aggregates which contain sulphur has been known to cause a floor to expand sufficiently to push walls out 2 inches and necessitate replacement of walls and floors. Troubles due to heat are experienced in foundations of boilers, furnaces, and gas retorts because of insufficient care in design. Where concrete may become excessively hot a lining of more than 4½ inches of fire brick should be provided and in addition provision should be made for reducing the temperature of the concrete. Aggregates for heat resistance should be carefully selected to avoid great volumetric changes and the concrete should be permitted a long curing period before using since hydration of cement and increase in strength cannot take place when the moisture is driven off by heat. Actual disintegration takes place at 460° C. Cracking due to too rapid drying may occur upon exposure to the sun or wind when the concrete is not kept wet. Dirty aggregate, which may cause failure to harden, may be detected by observing the staining effect when it is rubbed between the hands or by noting the deposition of loam or clay when the aggregate is stirred in a glass jar with water. Mortar briquettes may also be made for comparison with briquettes made with standard sand. Mixing water should be of a quality fit to drink. Excessive mixing water may not only cause reduced strength but serious segregation as well. Sea water troubles may generally be overcome by using a dense waterproof concrete, preferably with an integral waterproofing material, and by protecting fresh concrete from washing. A leak in an underground tank, manhole, or cellar may be repaired by cementing a small pipe in the hole and, when this is hard, plugging it with soft wood and cementing over. Troubles with floor surfaces may generally be traced to (1) insufficient preparation of the base concrete, causing loss of bond with the finish, (2) unsuitable or badly graded aggregate, (3) dirty or dusty aggregate, (4) excess mixing water and consequent late trowelling, or (5) too rich or too weak

mixture for the work in hand. The floor finish should be laid when the base is green or else thorough hacking, cleaning, and wetting of the surface is necessary. A very rich topping cannot be expected to contract integrally with a very lean base. Sound concrete is not damaged by freezing even if it is soaked with water, but porous or cracked concrete which permits liquid water to enter and freeze will eventually disintegrate.—V. P. JENSEN

Terminal facilities at Prescott, Ont. *Can. Eng.*, Jan. 14, 1930, V. 58, No. 2, p. 128.—A concrete grain elevator of 5,500,000 bushel capacity is now under construction. Elevator will be supported on concrete pier projecting into stream, and will be 1345 ft. long and 110 ft. high, with working unit along the top. Width is made up of three 20 ft. 6 in. diameter bins, 159 in all with 212 interspace bins divided into four sections.—G. M. WILLIAMS

How to save in concrete form work. (See FIELD CONSTRUCTION—*Miscellaneous.*)

ROADS AND PAVEMENTS

Massachusetts highways. A. W. DEAN. *Journal Boston Soc. C. E.*, Dec. 1929, p. 493-550.—Development of Massachusetts highways is traced from the Turnpike Era starting about one hundred and fifty years ago to present time. The present interest in tolls as a means of financing special highways, bridges and tunnels should profit by the experiences of these early roads. Turnpikes were not a financial success and within a comparatively few years became toll free public roads. In 1892 by an act of the State Legislature a Highway Commission was formed to develop a plan for construction and maintenance of a system of state and county roads. Report of this commission resulted in formation in 1893 of a permanent Highway Commission. Only a small appropriation was made at first for road work and this was used in developing small sections of road in as many counties as possible. The policy of the commission was to connect the large centers of business first, then the agricultural sections with these centers, and finally the smaller cities with railroad centers. Early work included a study of the available road materials, the development of a specification for water-bound macadam roads, investigation of bituminous binders for roads subjected to motor traffic, and the making of traffic courts. Highway bridges were placed under control of the Commission in 1912. The Highway Commission was merged in 1919 with the Commission on Waterways and Public Lands forming the Department of Public Works. The general policy of this department in regard to design of highways is given. They favor curves with radii of not less than 2500 ft. and gradients less than 6 per cent. Complete drainage of surface and subgrade, and proper visibility at summits of grades by providing 500 ft. clear view, are other standards of design. Reinforced concrete, bituminous macadam, and bituminous concrete are the principal types of roads at present employed for heavy traffic roads. Data are given in regard to mileage completed of all kinds of roads to date, as well as mileage finished in 1928. Details of the design, construction, and maintenance of the principal types of roads are outlined; and indicate a preference for the bituminous type except for the heaviest traffic conditions. Concrete roads are found to cost more and to require a greater outlay for maintenance. Work of the Department of Public Works insofar as highways are concerned includes in addition to items already mentioned, removal of snow on main routes, sanding of dangerous hills, and installation and maintenance of traffic signs and signals, and control of traffic. The Department makes its own signs and maintains a testing laboratory for investigation of materials and processes.

Methods of financing the state highways varied with the years and included bond issues, assessments on counties, cities, and towns, motor vehicle fees, Federal Aid, and finally gasoline tax. Figures quoted give expenditures since the formation of the first commission as $11,596,296.00.—MILES N. CLAIR

ARCHITECTURAL DESIGN

Surface treatments for pre-cast concrete. *The Builder* (England), Jan. 10, 1930, p. 145-47.—So many builders are now interested in the manufacture of pre-cast concrete, either in the form of dressings for buildings they are erecting or the mass-production of blocks, slabs, garden ornaments, etc., that some notes on the difficult problem of surface treatment should be valuable. Among the methods of treating the surface of pre-cast concrete and cast stone are the following: (1) Tooling, (2) Rubbing and polishing (3) Carving, (4) Reeded or ribbed surfaces, (5) White and colored cement rendering, (6) Exposed aggregate, (7) Colored concrete, (8) Colored cement washes, (9) Painting and staining. Since perhaps only those phases of the work which fall within the category of "decorative" treatment come within the heading "Architectural Design," only the last three items are abstracted. Mosaic Patterns: Cement decorative panels in colors may be made as follows: First, make a slab of the desired thickness in cement of the color that is to form the background, fixing blocking-pieces in the bottom of the mould to allow the pattern to be inserted. Care must be taken to taper these blocking-pieces so that they can be easily removed. When this slab has hardened, it is released from the mould, turned over, and the spaces filled with different colored cements in accordance with the design. When different colors are in juxtaposition to each other, that placed first must be allowed to dry out before the next is placed, in order to avoid the colors running into each other. If desired, the articles in which mosaic patterns are to be inlaid may be made face-up, pressing blocking-pieces into the face to the desired depth and, when these are removed, filling the space or spaces with colored concrete. If desired, the mosaic pattern may be pre-cast in separate pieces and grouted into the spaces blocked out for it. For stair treads or landings to be faced with a mosaic pattern, pieces of carborundum, alundum, or other nonslip materials may be used for the inlay. Painting With Cement: The art of painting with colored cement has been considerably developed during recent years, and some excellent pictures produced. One advantage of painting with cement is that the artist is not limited to two dimensions only, as a raised pattern may also be incorporated in the picture. Thus a portrait in colored cement may also be in relief. In this branch of the painters' craft, the artist has a range of colored cements and modellers' tools in addition to brushes. The colored cements are mixed to a stiff consistency and applied with a brush or spatula, taking care that the colors do not run into one another if this is not desired. This class of work is, of course, outside the scope of the pre-cast concrete works, but it has many interesting possibilities for outdoor permanent decoration in color and relief and for mural decoration. The process is, however, used to some extent by cast concrete manufacturers, particularly in the production of garden ornaments. It is, of course, impossible to use different shades of color in the concrete used for such purposes, with the result that garden statuary and like articles are monochrome when they leave the molds. Their appearance may, however, be enhanced when desired by the application of delicate shades of mineral oxides and pigments, and some very pleasant tinting and shading may be introduced by this means. For example, the appearance of depth of incised parts may be emphased by the application of black or dark grey, or the whole figure may be treated in the different shades of the same color. A simple method of carrying out this work is to rub the colors well into the figure with the fingers, or a small spray may be used. If the ornament thus treated contains pit-holes when taken from the mold, these can, of course, be filled in while the concrete is being tinted with colored oxides or pigments. Some particularly attractive tinted surfaces suitable for garden ornaments are obtainable in this way.—REXFORD NEWCOMB

Frankfurt housing scheme—the Siedlung "Romerstadt." HOWARD ROBERTSON AND F. R. YERBURY. *Architect Building News* (England),

Jan. 10, 1930, V. 62, No. 1, p. 73-76.—So interesting has been the program for housing and reconstruction of the City of Frankfurt that the second sitting of the International Congress for Modern Architecture was recently held there. The object of this year's meeting was to study the question of the "minimum" dwelling in all its aspects: construction, equipment, and the building regulations which affect it. No better place than Frankfurt could have been chosen for the meeting, since here is to be seen at first hand a demonstration of what can be done in improved housing under conditions of cost which are more onerous even than in this country. A general co-ordinating control of the various housing enterprises was considered indispensable; hence the creation of the office of "Stadtbaurat," the commander-in-chief of the army of private architects and contractors who carry out the details of the schemes. For it is made clear, in description of the Frankfurt housing, that the private architect is not eliminated. On the contrary, architects have collaborated in all the schemes, the general plan and certain standards of equipment which it is indispensable to agree upon if buildings are to be produced at an economic cost. Of these, the most important are the standardization of kitchen and bathroom fittings, the use of metal door frames built in as the work proceeds, flush ply-panelled doors, standard metal windows (some of which are fitted with glass louvres) and latterly the employment of a concrete composition slab unit, which is prepared away from the job on lines of factory production and even given its rendering coat in the same way. These standard slabs are quite large, 10 ft. long, 3 ft. 7 in. high, ¾ in. thick, and are used for external walls and main partitions. It has been possible with this system of factory production to construct the walling of a single family dwelling in 1½ days, and so encouraging have been the results in respect of reduction in cost that 400 of the latest houses are being erected on this system. The exteriors of the houses are very straightforward, with renderings of white, pink, or red, and windows painted blue. Overhangs and porches are of concrete, and the flat roofs serve as gardens in many cases.—REXFORD NEWCOMB

FIELD CONSTRUCTION

BRIDGES

Pier construction for the S. P. Railroad bridge across Suisum Bay. C. R. HARDING. *Eng. News Record,* Jan. 30, 1930, p. 174-180.—Substructure of bridge consists of 22 pedestal piers under approach viaducts two piers constructed in open cofferdam, and eight piers constructed by combination of dredging and open cofferdam methods. These ten piers are of reinforced concrete to provide resistance against earthquakes. Usually the bases are 38 x 60 ft. Maximum height of pier is 214 ft. The sides are vertical to elevation—20 where there is an abrupt change of section. Pier shafts begin at this level. A total of about 105,000 cu. yds. of concrete and 1500 tons of reinforcing steel will be used in these piers. Vertical and horizontal reinforcement is being used at edges of bases, in dredging wells, and between piers and shafts. A new and practical method was employed in sinking the concrete caissons. It consisted briefly in sinking a steel shell 81 ft. in diameter to bed rock, dredging out the mud and back filling with sand to form an island inside the shell. On this island of sand, forms for a reinforced concrete caisson were erected. Each caisson was provided with six dredging wells. A steel shoe was an integral part of each caisson. After reaching bed rock the wells were filled with concrete. All concrete, except a small amount at the bottoms of the dredging wells, was poured in the dry. Ten illustrations.—N. H. ROY

Remarkable concrete arch at Brest, France. (See ENGINEERING DESIGN.)

DAMS

Irrigation works construction in Mexico. R. M. CONNER AND ANDREW WEISS. *Eng. News Record*, Jan. 16, 1930, p. 101-104.—This project located on the Salado River, near Nuevo Laredo, Tamaulipas was described in *Eng. News Record* March 21, 1929, p. 453. It consists of an earthfill dam with concrete face and concrete spillway. Earth dikes have stone facings. Concrete retaining walls were built simultaneously with embankment. A portable crushing plant reduced limestone found near the site to aggregates of proper size. Two 1-yd. mixers immediately below the storage bins discharged concrete into side-dump cars, which delivered it to the forms for foundation for spillway piers. Concrete for outlet works and retaining wall was mixed by four ½-yd. mixers and delivered in side-dump cars, hand buggies and gravity chutes. Reinforced concrete slab for revetment to protect upstream face of earth dam was constructed 11 in. thick. Concrete was mixed in ½ yd. mixer and hauled to place in side-dump cars, facing being placed as a monolith, with continuous reinforcement, and built in alternate vertical strips 10 ft. wide.—N. H. ROY

High rock fill dam with jointed concrete face. (See ENGINEERING DESIGN—*Dams.*)

MISCELLANEOUS STRUCTURES.

Modern methods and equipment on Connelsville extension of Pittsburgh & West Virginia Ry. CHARLES M. NELSON. *Eng. & Conc.*, Jan. 1930, V. 69, No. 1, p. 1-8.—This project includes a variety of both concrete and steel structures. The largest concrete structures are three 25-ft. arches under heavy fills, and a skew underpass. There are a large number of arches, culverts, viaduct pedestals, bridge piers and abutments. One 735 ft. tunnel is lined with concrete and has a concrete floor. Practically all concrete was centrally mixed in three plants and was hauled successfully in open dump trucks as far as 14½ miles. Three per cent of celite was added to the mix. Some concrete was hauled and poured in zero weather. The drop in temperature was about one degree per mile. All concrete was workable and averaged 2500 lb. per sq. in. at 28 days.—N. H. ROY

Concrete troubles and how they should be avoided. (See ENGINEERING DESIGN—*Miscellaneous.*)

Notes on the foundations of a new Thames-side warehouse. (See ENGINEERING DESIGN—*Miscellaneous.*)

How to save in concrete form work. A. B. MACMILLAN. *Concrete*, Jan. 1930, V. 36, No. 1, p. 17.—In general, the most important points to be remembered are the following: (1) Forms must be rigidly braced and shored to prevent collapse. (2) Timber used must be heavy enough or sufficiently braced to prevent springing or bulging. (3) Weight should be as light as consistent with strength and rigidity. (4) Forms must be tight enough to prevent serious loss of mortar and to prevent formation of fins on surface of hardened concrete where mortar has run between loosely fitting boards. (5) Details of form work should be so devised as to simplify both erection and removal of forms and to permit repeated use of individual form units. (6) Size and weight of individual form units should not be greater than can be handled by the number of men in the form work crew. It is best not to exceed a 2-man load of 150 pounds.—C. BACHMANN

Transit - Mix Concrete Corp. solves many problems in marketing of concrete in New York City. W. E. TRAUFFER. *Pit and Quarry*, Jan. 15, v. 19, No. 8, p. 23-26.—Describes several plants, all but one of which use dry-batching. All have water-front locations and receive materials by barge. Franklin street plant unloads barges by a stiff-leg derrick. Sacked cement is trucked from barge to storehouse, then sacks are opened and loose cement elevated to 500-bbl. steel bin. Sand, gravel and cement are discharged to two weighing batchers. Cement batcher has a 3,000-lb. capacity and aggregate batcher 16,000-lb. Batchers discharge through a flexible spout to trucks. Water is measured into the tank on each truck. Mixing is done in transit or upon arrival at jobs, first

mixing materials dry and then adding water. The truck body is tilted during dumping. Eleven illustrations.—A. J. HOSKIN

SHOP MANUFACTURE

Block plant conveying methods. HAROLD T. HANSEN. *Concrete*, Jan. 1930, V. 36, No. 1, p. 31.—Notable among concrete products plants that have experimented with conveyors and have conclusively proved their worth, is a prosperous cast stone plant in Toledo, Ohio. Here the application of mechanical handling begins at the railroad siding with the incoming aggregates. A portable trough belt conveyor unloads a carload of sand and deposits it in storage bin in a few hours. Bagged cement is readily handled on pallets over roller conveyors. Four or five 8-ft. sections and a 90 degree curve reach from inside of car well into the storage warehouse. The freshly molded stone on its bottom board can be moved to temporary storage either on an overhead tramrail system or on a roller conveyor system. Flanged rollers are more adaptable than plain rollers with guard rails for transporting units.—C. BACHMANN

Collecting a million dollars. D. R. COLLINS. *Concrete*, Jan. 1930, V. 36, No. 1, p. 21.—The first move after the organization of the Milwaukee C. P. Co-Operative Assn. was the collection of credit information from members. Preliminary information was recorded on credit cards. Shortly after the entire group of cards was collected and sorted every account was analyzed and given the rating it deserved. The contents of the cards were transferred to a visible file beside the telephone operator's switchboard for use as a quick check-up on orders phoned in. Although the association has some six hundred accounts on its books at the present time an effort is made to check each of these frequently. This checking is done by the credit manager and by the salesmen who are actively in touch with the accounts. Billing is done in the association offices daily—that is, as a job progresses, the deliveries are taken from the manifest sheet explained in a previous article (cf. *Concrete*, Nov. 1929, V. 35, No. 5, p. 17) and entered on the invoice for the job in question. At end of month these invoices, together with a statement, are stapled together and mailed to the customer. Each statement is stamped with a rubber stamp stating a discount of 5 per cent will be allowed on previous month's business if paid for on or before the tenth of current month.—C. BACHMANN

Construction with "Triol-bricks." VON MENG. *Zement* (Germany), Dec. 1929, V. 18, No. 52, p. 1496-1498.—The "Triol-brick" is a building stone made of concrete with pumice as an aggregate. Every stone has definite dimensions and shape according to the purpose for which it is used. Porosity of stone and air spaces which are obtained in the walls give good heat insulation. The stone is frost proof and fireproof.—A. E. BEITLICH

Surface treatments for pre-cast concrete. (See ARCHITECTURAL DESIGN.)

Cement products industry in 1929. *Rock Products*, Jan. 4, 1930, V. 33, No. 1, p. 162-164.—Estimated output equivalent to 350,000,000 8 x 8 x 16-in. units during 1927, 384,000,000 units for 1928 and nearly 400,000,000 units during 1929. Growth of other products, notably cast stone and stave silos, indicated.—J. J. LANDY

Plastics in concrete. *Zement* (Germany), Dec. 1929, V. 18, No. 52, p. 1491-5.—A number of plastics made by Karl Himmelstoss (Germany) are described which show the possibilities for the use of concrete in the plastic art. Photographs are given.—A. E. BEITLICH

Merchandising concrete products—then and now. Part 3. T. A. DAY. *Rock Products*, Jan. 18, 1930, V. 33, No. 2, p. 87-88.—Sales methods of the Cast Stone Co. of St. Paul, Minn., described. Improvement in quality of units and design of buildings resulted in greater use of concrete masonry units for above-grade construction.—J. J. LANDY